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PEACE AND JUSTICE

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In our private dreams of a better world for our children and our children's children, and in the plans we debate in public discussions, we instinctively start from the premise that a just peace must be the immediate goal of all our efforts and the primary purpose of our victory. We seem to take it for granted that in seeking justice we shall find peace. It apparently never occurs to us that such a search might merely lead into new conflicts, although history teaches us that a demand for justice has always been the battle-cry of wars and rebellions. And anthropology has clearly shown that there is no universally accepted definition of righteousness from which the principles of universal justice might be derived.

Our concepts of right and wrong and therefore also of justice are products of our own traditions, valid and applicable only within the cultural pattern of which they form a part. In our Anglo-Saxon inclination to make justice an end in itself we fail to recognize the existence of these limitations. And in the frustration of our desire for universal principles in a field in which no generalizations are yet possible, we allow our own security to be undermined by our uncertainties, while we actively provoke new threats to our safety through needless conflicts over abstractions which have only been developed to serve as tools for the attainment of the higher ideal of health and happiness for all, within the particular design and conventions of our own society.

Today we are joined with our allies in dedication to a cause which extends its purposes beyond the boundaries of any particular society or civilization to which each of us belongs by his birth and by the traditions in which he has been reared. We have set as our aim the welfare of all humanity, regardless of creed, color, cultural traditions, or geography, because we have learned that only in a world in which such an ideal prevails can we also find complete and secure happiness for ourselves. The success of our efforts may depend upon our ability to recognize that the broadening of our purpose and of our ideals does not immediately, and by itself, remove the limitations of the methods which are valid and useful only against the background of our own traditions and ways of life. It is of supreme importance for us in this crisis of world history not to lose sight of the distinction between ends and means in order that our purpose shall not be defeated by a dogmatic insistence upon the methods and ideas to which we ourselves have become accustomed as members of a fairly homogeneous culture.

Setting as our aim the hallowed goal of education through the ages—*mens sana in corpore sano*—and extending it to embrace all humanity, let us immediately recognize that our only real and final purpose is purely biological, psychological, and spiritual, and that physical, economic, political, and legal measures and principles are only among the practical means of attaining our purpose. Let us further bear in mind that our justicial concepts and procedures are the tools least likely to prove of universal usefulness because they are most likely to be specifically identified with our own traditions alone.

Hunger and poverty feel alike and yield to the same treatment regardless of geography. The state is universally accepted as the

basic unit of international politics, and underneath the ideological differences of motives, purposes, and methods of government the organic structure of the states shows a high degree of similarity in all nations. Education deals with the same general fields of learning everywhere, and the basic processes by which knowledge is acquired are the same for all who seek it. A religious craving is common to all humanity and therefore capable of being understood and respected by all, even though the faiths in which it finds expression differ among the peoples. But the terrible war we are now fighting is renewed evidence that humanity has not yet reached a common ground in its judgments of right and wrong, and until it does we shall have no solid foundation on which to base a world-wide system of justice as a primary instrument for the improvement of human welfare.

If, in these circumstances, we try to make justice as we see it in our own tradition the immediate aim of our efforts, we shall find ourselves defeated by our own principles. In passing judgments upon the acts of man within our own society we have long recognized the moral significance of the motives behind the deed. If we attempt to deal in the same manner with acts committed in traditions entirely alien to our own way of thinking, we shall also be forced by our own convictions to give consideration to motivations entirely beyond our capacity to comprehend. And we shall become bewildered in our own judgments. We also accept the innocence of the insane, and evidence will accumulate to make us wonder about our right to condemn. We shall be lost in a wilderness of circumstances which our own experience does not enable us to understand and evaluate, and we may end by losing our cause because we attempt to reach our goal through an avenue of approach in which our habitual ways of reasoning do not apply.

But if we remember that justice is only one among many means to a higher end, its failure to serve in the particular state of the world today will not mean the failure of our aspirations, and we shall still be able to turn with equanimity to other methods of achieving the improvement of the human lot which is our actual goal. If we find it necessary, as we almost certainly shall, to make increasing allowances for debatable motivations, and to abide by the principle that even temporary insanity is not accountable before the bars of justice, we will also remember that neither do we let the criminally insane roam free to wreak their destruction upon our society. Nor will we forget that the purpose of the measures we must take is not suppression, but cure, in order that the principles and methods of justice which are bound to fail in application today may ultimately prevail throughout the world, as the most civilized means of attaining the greatest common good among all people.

The world is facing a titanic problem in bodily and mental health. It must be treated by methods immediately and universally applicable to the basic causes and realities of the situation. These methods are those practiced in medicine, psychology, psychiatry, public health, sociology, anthropology, engineering, economics, and statecraft. The methods of justice still face a long process of regional evolution within culture areas in which a kinship of ideas already exists, before these areas can ultimately be absorbed in a world-wide fusion of principles and aspirations common to all mankind. Any attempt to force this evolution by a premature imposition of our own particular concepts of abstract justice is bound to hinder rather than advance the progress of civilization of which we dream.

It is inherent in our psychology, and in the entire situation we are facing, that a peace formulated and proclaimed in the name of justice must begin as a hard peace, inspired by the wrath of our righteous indignation, only to end in the softness of doubts and uncertainties concerning the definition and application of the principles on which it was based. In the ultimate outcome it will therefore neither give satisfaction to the victims of aggression nor will it provide a cure for the spirit of the aggressors. History will remain free to repeat itself again until we finally learn to keep our main purpose unobscured by spiritual commitments on secondary questions as to the practical methods which, at any stage, may best serve the development of a better world.

THE ART AND SCIENCE OF CROP FEEDING

By CHARLES J. BRAND and H. R. SMALLEY
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THE total output of American farms in 1944 was 33 per cent above the 1935–39 average and 45 per cent above the 1910–14 average. This record production means that there has been plenty of food for the men in the armed services, for our Allies, and for a civilian consumption 7 per cent larger than in the prewar years.

There are actually fewer workers on farms than there were five years ago, 17 per cent fewer than the 1910–14 average. While millions of farm workers have gone into industry and to war, those remaining on the farms have worked longer hours, and wives and daughters have driven tractors and have done a thousand and one other jobs. Older men have come out of retirement to help; many office workers and teen-age youngsters have helped in many localities, as have war prisoners, soldiers, and laborers from Mexico and the West Indies. Moreover, the industries that provide farmers with machinery and equipment, fertilizer, liming materials, insecticides, feed, and seed have made an absolutely essential contribution.

In establishing this new all-time record of production during the war, farmers have demonstrated the enormous value of the scientific research that has been done by our State agricultural experiment stations, by the U. S. Department of Agriculture, and by private agencies in many fields. It is research that made possible the vertical expansion of agriculture, more produce per acre. The alternative is horizontal expansion, which means more acres, more manpower, and more horse or machine power.

Every branch of agricultural science has made a significant contribution to the expanded production program. The improvement of the soils; the use of fertilizers, lime, and manure; the growing of legumes and cover crops; and erosion control could not be fully effective in raising crop yields without the work of the plant breeder, the pathologist, and the entomologist. The plant breeder has given us high-yielding, often disease-resistant, varieties that can make use of increased soil fertility. Hybrid corn is an outstanding example of the breeder's work, but there are literally hundreds of others. And along with the improvement in soils and varieties, there must in many cases be developed a spraying or dusting program to control insects and plant diseases.

On the animal-production side, science has made equally effective contributions. Among the improvements in this field are breeding for higher production of milk and eggs; for more efficient meat production; and better methods of feeding animals for all purposes.

USE OF COMMERCIAL PLANT FOOD A FACTOR IN DETERMINING YIELD

Acreage yields of corn, wheat, and cotton were relatively constant for 50 or more years prior to 1937. Almost uniformly during that period increased production was the result of increase in the number of acres harvested. In contrast, since 1937 the factor of yield per acre has become ascendant, especially as to corn and cotton. Wheat also has shown an uptrend in yields per acre. These crops have consumed nearly 45 per cent of total commercial plant food used in recent years.

In the 17-year period from 1916 to 1932, we harvested on the average 102,000,000 acres of corn, producing an annual average of 2,646,000,000 bushels, with an average yield of 25.94 bushels per acre. In the 7-year period from 1937 to 1943, inclusive, we harvested 90,700,000 acres on the average, with an average production of 2,731,000,000 bushels, and an average yield per acre of 30.10 bushels for the period. In other words, with acreage harvested reduced by approximately 12,000,000 acres between the two periods, we nevertheless harvested an average of 85,000,000 bushels more on the smaller acreage.

The following figures show what has happened with respect to the fertilization of corn

acreage, comparing 1929 with two recent years:

Acreage of Corn Fertilized

In 1929	*In 1938*	*In 1942*
14,786,000	18,725,000	21,543,000

Not only did we have a direct increase of approximately 6,750,000 acres of corn fertilized, but we had a distinct increase from 1929 to 1942 of from 17.5 per cent to almost 21.0 per cent in the plant-food content of the fertilizers used.

Wheat ranks third, with corn and cotton first and second in acreage fertilized. Winter wheat is customarily responsible for about two-thirds of our total wheat production, and 12 of the Midwestern States ordinarily produce about 60 per cent of the winter-wheat crop. The 5-year average annual use of fertilizer in these States for 1930–1934 was 618,636 tons. Consumption in them in 1943 was 1,773,657 tons. The 5-year average annual yield of winter wheat in this group of States from 1930 to 1934 was 14.6 bushels per acre; for 1938 to 1942, inclusive, it was 16.4 bushels; in 1943 the average yield in the Midwest was 15.6; in 1944 it was 18.8.

An increase of more than 1,155,000 in tons of fertilizer used was not without considerable influence in maintaining and increasing wheat yields. One ton of average fertilizer produces an average increase in yield of 85 bushels of wheat.

A brief comparison of wheat yields of two groups of nations is given below. Those in the first list use fertilizers with reasonable adequacy, and those in the second do not. Rainfall and other factors, of course, account for some of the difference.

Average Yields of Wheat for 1930–1934

Country	*Bushels per acre*
Sweden	33.3
United Kingdom	33.3
Germany	32.1
Austria	23.6
France	23.0
Spain	14.1
Argentina	13.8
Canada	13.6
United States	13.5
Australia	12.2

Fertilization of Cotton. Only for cotton do we have relatively detailed and accurate estimates. They have been made yearly since 1922 by the U. S. Department of Agriculture. A general indication of what has happened in cotton growing since 1925 is given below:

Cotton Fertilization and Yields

Period	Av. acres harvested per year	Av. number of bales per year	Per cent acres fertilized	Per cent of 1925–29 average	Av. yield per acre (pounds)	Per cent of 1925–29 average
1925–29	42,600,000	15,268,200	35.4	100.0	179.2	100.0
1934–39	34,658,000	12,563,000	35.6	100.6	181.2	101.1
1938–42	23,219,000	11,977,400	43.4	122.6	272.4	152.0
1944	20,098,000	12,359,000	46.1	130.2	295.3	164.8

	1929	*1938*	*1944*
Cotton acreage in cultivation as of July 1	44,448,000	25,018,000	20,472,000
Cotton acreage fertilized	16,811,000	10,294,000	9,435,000
Per cent fertilized	37.8	40.4	46.1
Pounds of fertilizer applied per acre	265.4	282.4	328.0
Estimated plant-food content of fertilizer used	14 to 15%	16.0%	18.0%
Average yield of lint per acre	164.2	235.8	295.3

Increase in the average yield of cotton between 1929 and 1944 is due among other things to (1) an increase in the proportion of acres of higher fertility kept in cotton as the enormous cut in acreage took place; (2) an increase of nearly 10 per cent in the number of acres receiving fertilizer; (3) an increase of from 265.4 pounds applied in 1929 to 328 pounds in 1944; and (4) an increase of possibly 20 per cent in the plant-food content of the fertilizer used on cotton.

Other factors that should not be overlooked are more favorable weather, more general planting of higher-yielding strains and varieties, better placement of fertilizer in the soil (not in contact with the seed, which is injurious), and better cultivation, which improves the condition of the soil and helps to control weeds and to conserve moisture. In the longer view of the past, increased mechanization of all farming has also had a very great effect.

Recently Dr. Ralph W. Cummings, of the North Carolina Agricultural Experiment Station, stated that commercial plant food probably accounted for more than 50 per cent of the total cotton production obtained in his State in 1943. A crop of 500 pounds of lint with its accompanying 750 pounds of seed removes from the land about 27 pounds of nitrogen, 12.5 pounds of phosphoric acid, and 12.5 pounds of potash.

Correct fertilization improves both yield and quality of crops. Years of experimentation and statistical studies warrant the conclusion that a ton of the average grade customarily used on corn produces a yield increase of 125 bushels; on cotton, 2 bales of 500 pounds each; and on wheat, 85 bushels.

With the foregoing background of practical agronomic and economic facts, we proceed to sketch briefly the history of the art and science of crop feeding, the development of the modern chemical fertilizer industry, and its present status.

History of the Development of Crop Feeding

The use of animal manures as a means of enriching the land dates back to the dawn of human history. The agricultural writers of ancient Greece and Rome discussed the relative merits of various kinds of manures and composts made from manures and crop residues. Nearly 1900 years ago, Pliny the Elder, in his *Historia Naturalis*, discussed the value of green manures, stating that "it is universally agreed by all writers that there is nothing more beneficial than to turn up a crop of Lupines, before they have podded, with either the plough or the fork, or else to cut them and bury them in heaps at the roots of trees and vines. It is thought, also, that in places where no cattle are kept, it is advantageous to manure the earth with stubble or even fern." Thus the value of turning under legumes, as a means of increasing soil fertility, was known in the first century A.D., although the fundamental reason for this value was not discovered until nearly the end of the nineteenth century, when two German investigators, Hellriegel and Wilfarth, proved that the bacteria which live in the nodules on the roots of legumes are able to fix atmospheric nitrogen.

It is also apparent from the writings of Pliny and others that the use of marl and other forms of lime would improve many soils. He discussed the merits of different forms of marl and stated that it was used chiefly in the Gallic provinces and in the British Isles.

The science of plant feeding in any modern sense—knowledge of the soil and of the chemical elements essential to plant growth—had its real beginning only about 100 years ago, and it was also just about a century ago that the manufacture of chemical fertilizer was begun in England.

If we go back a little over 300 years we find van Helmont, a Belgian physician and scientist, growing a tree in an earthen pot. He weighed it at the start and after five years found that it had gained 164 pounds. The soil weighed practically the same as at the beginning, so he concluded that the increased weight must have come from water and that water must be the true plant food.

In England more than 200 years ago Jethro Tull (1674–1741), a landowner and a graduate of Oxford, published (1733) his *Horse Hoeing Husbandry*. He proposed that *earth* was the true food of plants; that by

better tilling, the particles of soil could be made fine enough to be taken up by plant roots; that tilling could be used as a substitute for manure.

During the next 100 years (1740–1840) great progress was made in chemistry, so essential to an understanding of plant growth. The French chemist Lavoisier, during the latter half of the eighteenth century, explained the true nature of combustion; that it is an oxidation process and that the end product is carbon dioxide.

Henry Cavendish (1731–1810), a famous English chemist and physicist, was the first to determine the comparative weight and quantity of gases produced by the decomposition of plant and animal substances.

Joseph Priestley (1733–1804) made his contribution by discovering oxygen and also by carrying on many experiments dealing with plant and animal nutrition. Jan Ingen-Housz (1730–1799), a Dutch physician, proved that the absorption of carbon dioxide and the giving off of oxygen are plant functions that can take place only in the presence of light.

Jean Senebier (1742–1809), a Swiss clergyman and a scientist, was the first to explain the process which we now know as photosynthesis—the formation of carbohydrates in the plant from carbon dioxide and water with the aid of sunlight.

Theodore de Saussure (1767–1845) was, according to Dr. C. A. Browne, "attracted to chemistry by the work of Lavoisier, and his special interest in experimental plant chemistry was stimulated by the work of Priestley, IngenHousz, and Senebier." Dr. Browne says: "It was Lavoisier who chiefly helped to provide the foundation stones of modern agricultural chemistry, but it was Theodore de Saussure who put them in place." And Sir John Russell says: "To him is due the quantitative experimental method which more than anything else has made modern agricultural chemistry possible; which formed the basis of subsequent work by Boussingault, Liebig, Lawes, and Gilbert."

Carl S. Sprengel (1787–1859), a native of Hanover, Germany, made a larger contribution to the science of plant feeding than is usually accredited to him. Browne says of him: "It is strange that his name should have been so completely overlooked by later writers, although he was the first to announce many of the ideas that have been wrongly accredited to Liebig and other later investigators." His list of 15 chemical elements which he considered to be essential to crop growth includes 11 of those which are now regarded as necessary. The 11 elements were: oxygen, carbon, hydrogen, nitrogen, sulphur, phosphorus, potassium, calcium, magnesium, iron, and manganese. We now add only copper, zinc, and boron to this list. He pointed out that if only one of the elements necessary for growth be lacking the plant will not thrive, even though all the others occur in abundance—a statement which is as true today as it was then.

The first scientist to conduct actual field experiments was Jean Baptiste Boussingault (1802–1887). He began his experiments on his farm in Alsace about 1834 and described them in a series of articles published in 1836 and succeeding years. In discussing his work Dr. C. A. Browne says that "until the third decade of the 19th century, agricultural chemists had occupied themselves chiefly with the problems of chemical composition and very little with the problems of mutual chemical relations. Much knowledge had been accumulated concerning the elementary composition of agricultural products, but no one had yet attempted to follow the balance of chemical elements in the growing of a crop or in the feeding of an animal. He first made agricultural chemistry a true experimental science by transferring it from the laboratory to the field and stable." To him, says Sir John Russell, "belongs the honor of having produced the method by which the new agricultural science was to be developed. He reintroduced the quantitative method of de Saussure, weighed and analyzed the manures used and the crops obtained, and at the end of the rotation drew up a balance sheet showing how far the manures had satisfied the needs of the crops, and how far other sources of supply—air, rain, and soil—had been drawn upon. . . . Boussingault's work covered the whole range of agriculture and deals with the composition

of crops at different stages of their growth, with soils, and with the problems of animal nutrition. Unfortunately the classic farm of Bechelbronn did not remain a center of agricultural research and the experiments came to an end."

The year 1840 has great significance for the student of agricultural chemistry, particularly to the student of plant nutrition, and also to the manufacturer of chemical fertilizer. It was in 1840 that Justus von Liebig, the famous German chemist, was invited to report to the British Association for the Advancement of Science on the state of organic chemistry. This report was amplified and published the same year as *Chemistry in its Application to Agriculture and Physiology.* Sir John Russell states that "this report came like a thunderbolt upon the world of science. With polished inventive and a fine sarcasm he (Liebig) holds up to scorn the plant physiologists of his day for their continued adhesion, in spite of accumulated evidence, to the view that plants derive their carbon from the soil and not from the carbonic acid of the air. . . . Liebig's ridicule did what neither de Saussure's nor Boussingault's logic had done. It finally killed the humus theory (the theory that plants derived their carbon from the organic content of the soil)."

After taking his degrees at Bonn and Erlangen, Liebig through the sponsorship of von Humboldt was enabled to spend two years in Paris with Gay-Lussac. In 1824 he became professor of chemistry at the University of Giessen. There he became famous as a teacher and investigator in organic chemistry, serving until 1852, when he went to Munich. His teaching and personality attracted pupils from all parts of the world.

His great ability as analyst, teacher, and editor enabled Liebig to include in his book a review of existing knowledge which attracted immediate attention. By 1848 the book had gone through 17 editions and translations and was constantly revised by the author. It contained over 200 references to the work of approximately 100 different authors but did not report much in the way of original research. Liebig stated that the hydrogen and oxygen used by plants came from water; the nitrogen from ammonia; that certain mineral substances were essential; alkalies were needed for neutralizing the acids developed within the plant; phosphates were necessary for seed formation, and potassium silicates for development of grasses and cereals. He stated that the fertility of the soil could be maintained by returning, in the form of manure or chemicals, the mineral constituents and the nitrogen removed in the crops; that when sufficient crop analyses had been made it would be possible to tell the farmer exactly what he should add in any particular case. (Present-day agronomists would be happy if that last suggestion of Liebig's were really true.)

Perhaps the greatest contribution made by Liebig was the stimulus which the publication of his book gave to other research workers in the field of plant feeding. Even the controversies which he started bore valuable fruit in later years.

One of those who listened most attentively to Liebig's report in 1840 was a young Englishman, Sir John Bennet Lawes, who even then had begun his famous experiments at his country estate at Rothamsted. Fittingly, Gay-Lussac's student Liebig had treated bones with sulphuric acid in order to make the phosphate more available to plants, but Lawes figured that, since the supply of bones was limited, natural phosphates might be so treated with equally good results. He experimented, and in 1842 patented his process for the manufacture of superphosphate. For the next 30 years he engaged in the manufacture of superphosphate on a large scale and spent a great deal of his wealth in establishing the Rothamsted Experimental Station, the forerunner of all the agricultural experiment stations that we have in the world today. Thus the science of plant feeding and its close ally—the manufacture of chemical plant foods—really began to develop in a modern sense during the years 1840 and 1842.

Experiment Stations and Other Agencies Enter the Field

The establishment of the now famous Rothamsted Experimental Station at Harpenden, England, in 1843 is customarily re-

garded as the beginning of the modern period in soil and plant research, particularly as it relates to the maintenance of and increase in crop yields through crop rotation, the use of manures and fertilizers, and other soil management practices. Speaking of this early period, Sir John Russell says that "farmers were slow to believe that 'chemical manures' could ever do more than stimulate the crop, and declared they must ultimately exhaust the ground. The Rothamsted plots falsified this prediction; manured year after year with the same substances and sown always with the same crops, they even now . . . continue to produce good crops . . ."

Interest in soil improvement and in plant nutrition developed rather more slowly in the United States than in Europe, largely because our land was newer and there was still plenty of land that could be had almost for the asking. Many of the leading farmers belonged to agricultural societies and were thus able to keep in touch with the development of new methods and practices. The value of liming the soil was fairly well known prior to 1840, due largely to the experiments and the writings of Edmund Ruffin of Virginia. His essay on *Calcareous Manures*, first published in 1821, was amplified and published in book form, the fifth edition appearing in 1852.

Two editions of Liebig's book were published in this country before 1848 and did much to arouse interest in soil chemistry. Also a considerable number of students who went abroad to study in European universities were coming in contact with the work of Liebig and other scientists on the Continent and with the work of Lawes and Gilbert at Rothamsted. Returning, many of these students became leaders in agricultural research in this country. Space limits forbid details, but some experiments with fertilizers were conducted prior to 1860. Experiments were conducted in Pennsylvania in 1857, in Maryland in 1858, in Michigan in 1863, in New Jersey in 1865, in Massachusetts in 1867, in Maine in 1868, in Illinois in 1871, and in Kansas in 1872.

Passage of the Morrill Act by Congress in 1862 made possible the eventual establishment of an agricultural college in each of the 48 States and provided a strong stimulus to agricultural education and research. During the next 25 years experiment stations were established in a number of States without Federal aid, and a number of experiments with fertilizers were conducted. The best known of these are the Morrow Plots, established at the University of Illinois in 1876, and the Jordan Plots at Pennsylvania State College, started in 1881. These are the oldest permanent experimental plots in this country, and they are still being continued.

In 1887 the Hatch Act was passed by Congress providing for the establishment of an agricultural experiment station in each State. This law established the principle of matching Federal with State funds and has made possible the building of an organization for agricultural research in this country which is not equaled by that of any other country.

After 1887 experimental work in the field of plant nutrition grew rapidly. Experiments involving the use of fertilizers, liming materials, manures, and crop rotations were started in most of the eastern, southern, and middle-western States. This work was supplemented by many experiments conducted in the greenhouse and by a vast amount of chemical analysis of soils and crops. For a long time agricultural chemists believed, with Liebig, that by analyzing the soil and the crop they should be able to tell the farmer exactly what fertilizer he should use. But field experiments indicated clearly that chemical analysis alone was not a practical solution to the problem. It was shown that although a soil may contain a relatively large quantity of total phosphorus or potassium only a small amount might be available during any crop year. The chemists then tried to devise means of determining the *available* plant-food content of the soils, and work along this line has continued to the present time. So-called "quick methods" of analyzing, or testing, soils for their available plant-food content are now in use in nearly every State.

Progress has also been made in plant analysis, and many methods are now avail-

able which indicate the nutrient status of plants at any stage of growth. Often the use of these methods makes it possible for the grower to make supplementary applications of fertilizer to correct a specific deficiency.

During the past 25 years agronomists, horticulturists, plant physiologists, and plant pathologists have made an intensive study of symptoms that develop in plants as a result of deficiencies of the various essential elements. Many of these symptoms are accurately described and illustrated in *Hunger Signs in Crops*, published by the American Society of Agronomy and The National Fertilizer Association. It is not yet possible for the agricultural scientist or the extension teacher to tell a farmer precisely what fertilizers will give the best results on a particullar field and crop, but it is possible to make very intelligible recommendations, far more accurate ones, in fact, than could have been made even 10 years ago. To make a good recommendation it is necessary to know the characteristics of the soil, its previous treatment, its degree of acidity or alkalinity, and its available content of the more essential mineral elements, particularly phosphorus and potassium. The results of experiments on the same soil type are always helpful, as are, of course, visible symptoms of the plant-food deficiencies. Plant-food analyses and tests are often employed when diagnosis is difficult.

The Modern Fertilizer Industry Develops

We have stated above that the manufacture of commercial fertilizers in a modern sense really began in 1842, when Sir John Lawes patented his process for the manufacture of superphosphate. The art of crop feeding could not develop until science had pointed the way. Up to that time farmers had depended upon animal manures supplemented, to some extent, by lime. Animal bones had also been used to some extent. In 1824 two barrels of Peruvian guano arrived in Baltimore for someone to try as a fertilizer, and in 1832 the first commercial importation of Peruvian guano was made. In 1830 the first Chilean nitrate arrived in Norfolk, Va. In 1840 the first by-product ammonia salts were produced in England, and sulphate of ammonia was sold as a fertilizer in England from that time on, but it was not produced in this country until 50 years later. In 1845 Liebig demonstrated the value of potash as a fertilizer, but its actual use dates from about 1860.

The first mixed fertilizers were made in Baltimore about 1850, and by 1855 "manipulated guanos" were being sold up and down the Atlantic coast. These fertilizers contained only nitrogen and phosphoric acid. As late as 1868 only about 50,000 tons of mixed fertilizers were used in the United States.

Peruvian and other guanos were the principal fertilizers used from 1840 to 1870. Guano was a good fertilizer, but it varied greatly in composition. The supplies were rapidly depleted, although small quantities have been imported all through the years, and still are.

The American fertilizer industry really began to develop in earnest when the value of the South Carolina phosphate deposits was recognized in 1867, and the production of superphosphate on a large scale was thus made possible.

Potash salts were first imported from Germany in 1869 or 1870, and from 1870 until the World War began in 1914 manufacture of fertilizer and its use on American farms developed rapidly.

Animal by-products and cottonseed meal became available for use in fertilizers in increasing volume, potash salts were imported from Germany and nitrate of soda from Chile, and the Florida and Tennessee phosphate deposits were discovered and worked on a large scale. Superphosphate production increased from 31,000 tons in 1868 to more than 3,000,000 tons in 1913.

Until 1914 the nitrogen in mixed fertilizers was derived mainly from animal by-products, cottonseed meal, and Chilean nitrate. Sulphate of ammonia production had been increasing gradually since 1893, and cyanamide produced at Niagara Falls, Canada, came on the fertilizer market about 1910. All our fertilizer potash, prior to

World War I, came from Germany. The American potash industry was not yet born.

The year 1914 marked the beginning of vast changes in fertilizer manufacture, with the result that fertilizers became better and relatively cheaper.

As the use of fertilizers developed, the industry grew until at present there are about 900 plants located in consuming areas. The table below shows that the total consumption of mixed fertilizers and of all fertilizer materials has increased from 1,150,000 tons in 1880 to about 12,000,000 tons in 1944.

CONSUMPTION OF FERTILIZER IN THE UNITED STATES

Mixed Fertilizer and Materials

Year	*Tons*	*Year*	*Tons*
1880	1,150,000	1925	7,334,000
1890	1,950,000	1930	8,222,000
1900	2,200,000	1935	6,276,000
1910	5,453,000	1940	8,303,000
1920	7,177,000	1944	12,000,000*

* Preliminary estimate.

About 70 per cent of the fertilizer used in the United States is applied in the form of mixed fertilizers, the rest as single materials. Most mixed fertilizers supply nitrogen, phosphorus, and potassium, as these are the three plant foods most frequently needed on the great majority of soils, but in some areas and for some crops other elements are needed, for example, magnesium, boron, manganese, zinc, copper, and iron, and these are often included in fertilizer mixtures. Large quantities of calcium and sulphur are supplied in most mixed fertilizers and in several of the fertilizer materials. These elements are essential to plant growth, but deficiencies are not commonly observed in the field because of the large quantities present in most soils and applied in fertilizers.

Nitrogen. Nitrogen is an essential constituent of powder and other explosives, a necessary constituent of animal and plant proteins, and, of course, of animal feeds. It is also one of the three major plant foods. Thus, as powder, protein, or plant food, nitrogen plays a big part both in war and in peace.

World War I created an enormous demand for nitrates, both for use in making explosives and for fertilizers. Other countries could still get Chilean nitrate, but Germany could not, so she developed a great air-nitrogen industry. Following the war, our air-nitrogen industry developed rapidly, but by-product sulphate of ammonia continued to be the principal source of nitrogen used in mixed fertilizer, and we are still importing large quantities of Chilean nitrates and, to a less extent, cyanamide and, recently, ammonium nitrate from the war nitrogen plants of Canada. Synthetic nitrate of soda produced by our domestic air-nitrogen industry has been on the market for some 15 years. It is produced in substantial quantities. Nitrogen solutions, containing ammonia, ammonium nitrate, and urea, are important constituents of mixed fertilizers.

A tremendous expansion in the production of nitrogen from the air was planned at the very beginning of the defense program in order to insure ample nitrogen supplies for munitions, for industry, and for agriculture. Despite competitive demands, agriculture has fared well, as indicated by the figures in the following table. Measured by the

CONSUMPTION OF NITROGEN IN THE UNITED STATES

(Short Tons)

1880	18,800	1930	375,800
1890	45,000	1935	306,100
1900	71,800	1940	413,100
1910	145,400	1944	600,000
1920	227,800		

tremendously expanded demand, there was some shortage of nitrogen in 1942 and 1943, and there is a slight shortage at present, due to the exceedingly heavy demand for explosives.

About half of the nitrogen used as fertilizers is used in mixtures and about half of it is used alone as side and top dressings. Prior to World War I large quantities of by-product organic materials, such as cottonseed meal and animal tankages, were used as fertilizer, but these materials are now used almost entirely in animal feeds. Fertilizer

nitrogen now comes mainly from chemical sources, such as ammonium sulphate, nitrate of soda, ammonia solutions, ammonium nitrate, cyanamide, and urea.

Phosphoric Acid. Available phosphoric acid used in fertilizers is obtained almost exclusively from superphosphate. Bone meal, once important as a fertilizer, is now used almost entirely in animal feeds. Some ammonium phosphates and basic slag are used, but the total quantities are negligible when compared with superphosphate. Superphosphate is now produced in about 170 plants, which are located in regions where consumption is largest. For example, the Carolinas, Georgia, Florida, and Alabama use about half of the fertilizer and have about half of the superphosphate plants. The raw materials used in the production of superphosphate are phosphate rock and sulphuric acid. Many plants are equipped to make their own sulphuric acid; hence, their raw materials are phosphate rock and sulphur.

Superphosphate has been produced in this country since about 1850. It was first made from spent bone black, later from rock from West Indian phosphate deposits. When the South Carolina deposits were discovered in 1867 production began to increase rapidly. In 1920, annual production for the first time exceeded 5,000,000 tons. It did not again reach that level until 1941. Plant capacity has always exceeded production and demand, and the big increase in production during the past few years was accomplished with little new plant construction.

Our reserves of phosphate rock, which are located mainly in Florida, Tennessee, and the intermountain States of Montana, Idaho, Wyoming, and Utah, are sufficient to last from 2,000 to 5,000 years. In addition, there are some 2,000,000 acres yet to be examined in the intermountain States, and geologists believe that additional phosphate deposits may be found.

The production of superphosphate since 1880 is shown in the accompanying table.

PRODUCTION OF SUPERPHOSPHATE IN THE UNITED STATES

(Basis 18 per cent P_2O_5)

1880	205,000	1925	4,040,000
1890	480,000	1930	4,415,000
1900	1,505,000	1935	2,950,000
1910	2,595,000	1940	4,865,000
1920	5,130,000	1944	7,000,000*

* Preliminary estimate.

Potash. The cutting off of our potash supply from Germany at the outbreak of World War I intensified the search for potash in this country by Government agencies, private firms, and individuals. The development of our potash industry from a small beginning in 1915 to our present annual production of more than 800,000 tons of actual potash (K_2O) is a most interesting story and a record of which American private industry can well be proud. As recently as 1938, 40 per cent of our potash was still coming from Europe, and although our imports are now practically nil, both American farmers and American industry are using potash at the highest rate ever attained. The consumption of potash as fertilizer is shown below:

POTASH CONSUMPTION IN AGRICULTURE, 1880–1944, IN CONTINENTAL UNITED STATES*

Tons actual potash (K_2O)

Year	*Imported*	*Domestic*	*Total*
1880	20,000	....	20,000
1890	30,000	....	30,000
1900	60,000	....	60,000
1910	270,000	....	270,000
1920	170,000	40,000	210,000
1925	250,000	25,000	275,000
1930	305,000	45,000	350,000
1935	165,000	135,000	300,000
1940	70,000	340,000	410,000
1944	....	610,000	610,000

* Data supplied by the American Potash Institute, Inc.

CONCLUSION

In 1798 Thomas Malthus, the English sociologist, promulgated his theory that poverty and distress are unavoidable, since population increases by geometric ratio and the means of subsistence by arithmetic ratio; that therefore war, famine, and disease are necessary as checks on population increase.

A century later (1898) Sir William Crookes, in his presidential address before the British Association for the Advancement of Science, startled the world by calling attention to the seriousness of the wheat problem. The acreage of wheatland could not be increased very much, he said, except at the expense of other crops also needed, and the alternative was higher yields per acre. This could easily be accomplished by the use of nitrogen fertilizers, but the exhaustion of the natural deposits of Chilean nitrate was in sight and supplies of nitrogen from other sources were not sufficient. Crookes was a great scientist and was thinking far in advance of his time. What he was really trying to show was that some means must be found for fixing atmospheric nitrogen; in fact, he had shown how this could be done by the electric-arc process, the first process used for fixing atmospheric nitrogen and long since discarded because of its high cost. Nevertheless, Crookes stimulated research and pointed the way to a great development.

Since 1898 the whole nitrogen picture has changed completely. We now have within relatively easy reach an unlimited supply of air nitrogen to supplement our by-product production and our importations of Chilean nitrate—not to mention our enormous soil reserves of nitrogen, or the nitrogen fixed by the bacteria in the nodules that grow on the roots of leguminous plants and by other soil organisms, or the large revolving supply in manures and crop residues, or even that which is brought down in rain. Our known reserves of phosphate rock are sufficient to last at least 2,000 years, and we have enough potash in sight to last at least 100 years, with the probability that much more will be found.

Our farmers, aided by science and extension teaching, are now able to utilize commercial fertilizers efficiently, and we estimate conservatively that 20 per cent of our present agricultural output can be credited to fertilizer use. This percentage varies greatly from State to State, also for the various crops. We have been able to meet the greatly increased demand for food, feed, fiber, and raw materials by expanding our agriculture *vertically;* that is, by increasing yield per acre, rather than by horizontal expansion, which means more acres and an increase in manpower, horsepower, and machine power, which we did not have. We estimate that fertilizer use has obviated putting into cultivation at least 50,000,000 acres of additional cropland.

Fertilizer is now being used on about 70,000,000 acres, one-fifth of the total harvested acreage. There are approximately 175,000,000 acres of other cropland on which fertilizer could be used to advantage, and besides that there are 175,000,000 acres of pastureland which could be improved through fertilization as the need develops for increased livestock production. Thus there is ample opportunity for expanding our agriculture on present acreage to meet our needs for a long time to come.

THE LEGEND OF CINCHONA

By GEORGE URDANG

DIRECTOR, AMERICAN INSTITUTE OF THE HISTORY OF PHARMACY

AMONG the many blessings which the American continent presented to the people of the Old World, the bark of that group of evergreen trees called *Cinchona* has certainly been one of the most wonderful.

Everybody knows that this bark and its alkaloids, especially quinine, first isolated by the French pharmacists Pelletier and Caventou, have proved to be still irreplaceable for the treatment of intermittent fevers, of ague and malaria, and that the white man's settlement and warfare in large areas of the world would have been impossible without these drugs. The question arises and has, indeed, been asked throughout the centuries: how came the people of the Old World to know of and learn to use the miraculous drug?

The beginnings of the use of *Cinchona* bark as an antifebrile are still clouded in mystery. There is no evidence that the natives in Peru knew of the unique qualities of its contents and employed it as a drug before the arrival of the Spaniards. Furthermore, there was much confusion as to the real fever bark. For centuries the bark of the Peruvian balsam tree was used illicitly, as well as in good faith, instead of that of *Cinchona*, and the nomenclature was uncertain. Flückiger and Hanbury stated in their excellent *Pharmacographia* (second edition, London, 1879) the following:

> Humboldt [who visited the areas concerned in 1802] declares that at Loxa the natives would rather die than have recourse to what they consider so dangerous a remedy. Pöppig (1830) found a strong prejudice to prevail among the people of Huanuco against *Cinchona* as a remedy for fevers, and the same fact was observed farther north by Spruce in 1861. The latter traveller narrates that it was impossible to convince the *cascarilleros* of Ecuador that their Red Bark could be wanted for any other purpose than dyeing cloth; and that even at Guayaquil there was a general dislike to the use of quinine.
>
> Markham [1862] notices the curious fact that the wallets of the native itinerant doctors, who from father to son have plied their art since the days of the Incas, never contain *cinchona* bark.
>
> Although Peru was discovered in 1513 and submitted to the Spanish yoke by the middle of the century, no mention has been found of the febrifuge bark with which the name of the country is connected ["Peruvian bark"], earlier than the commencement of the seventeenth century.

There is a growing tendency to assume that malaria was not known in the South Americas before the arrival of the Spaniards, but was one of the diseases imported by the conquerors into the new country. This theory explains the lack of knowledge of the antifebrile effect of the *Cinchona* or Peruvian bark on the part of the Indians. However, if it was not them, who then did find out what nature had in store for suffering mankind in these wrinkled brown external coverings of a group of tropical trees?

It is known that the Spaniards learned from the Indians very early about the medicinal virtues of the balsam obtained from the Peruvian balsam tree, and that the Spanish Jesuits in their systematic endeavor to find some drug for the treatment of intermittent fevers subjected the bark of this tree, the bitter taste of which intimated some effective constituent to what would be called today clinical experiments. Achieving some, although limited, results, was it not logical to investigate other bitter barks as to similar, if not even better, effects, and that in this way finally the *Cinchona* bark and its miraculous qualities were discovered? After all, the prominent part played by the Jesuits in the early distribution and advocacy of *Cinchona* bark as a remedy for intermittent fever belongs to the few facts concerning the early history of *Cinchona* that are definitely assured.

The first mention of the genuine *Cinchona* bark by a European writer is contained in the *Cronica Moralizada del Orden de San Augustin en el Perú* of the Augustinian monk Antonio de la Calancha, bearing an ecclesiastical imprimatur dated 1633 at Lima. In this booklet Calancha writes:

> A tree grows which they call "the fever tree" in

the country of Loxa, whose bark, of the colour of cinnamon, made into powder amounting to the weight of two small silver coins and given as a beverage, cures the fevers and tertianas; it has produced miraculous results in Lima.

Calancha does not use an Indian term for the tree. He reports the meaningful Spanish name *Arbol de Calenturas* (fever tree), coined apparently by the grateful Spaniards who were cured by the wonder bark. There is attached no romantic story concerning the discovery of the miraculous drug or special circumstances preceding its introduction. The same holds true for the report on the "fever tree" given by the Jesuit Bernabe Cobo, who lived in Peru and Mexico from 1596 to 1653, in his *Historia del Nuevo Mundo.*

Every one familiar with folklore knows that very soon the one or the other story had to be invented in order to satisfy the deeply rooted human need for the extraordinary embellishment of the extraordinary.

There was very early the story of a lion who, shaken by fever, was observed drinking from a pond into which *Cinchona* bark was fallen, and immediately recovered. This was too legendary, of course, to be accepted as the truth not only by the plain people but also by scientists. There was, however, another story which was brought to public attention in the second half of the seventeenth century and which was believed by the learned as well as the unlearned until quite recently. It was the legend of the cure of the Countess of Chinchon, the wife of the Viceroy of Peru, by samples of the miraculous bark sent to her husband by the Governor of Loxa. Sebastiano Bado, an Italian physician and one of the most ardent promoters of the use of the antifebrile bark who gives the first account of this cure in a booklet published in 1663, says that he derived his information from a letter written by an Italian merchant who lived many years in Peru and redated the event "thirty or fourty [sic] years," meaning the time between 1623 and 1633.

When this [the happy cure] was learned in the City of Lima, the people approached the Vicereine by intermediaries, not so much joyfully and congratulatory, but supplicatingly, begging her to deign to help them, and say, if she would, by what remedy she had at last so marvelously, so quickly, recovered, so that they, who often suffered from precisely this fever could also provide for themselves.

The Countess at once agreed. She not only told them what the remedy was, but ordered a large quantity of it to be sent to her, to relieve the sufferings of the citizens, who often suffered from the fever. Nor did she only order this great remedy the Bark to be brought, but she wished to dispense it to the many sick with her own hands. And the thing turned out so well that just as she herself had experienced the generous hands of God in that miraculous remedy, so all the needy who took it marvelously recovered their health. And this bark was afterwards called Countess's Powder, which in Spanish is *los polvos de la Condeça.*

Since then this story has had a fixed place in all reports on *Cinchona* and its history. Following a well-known rule of folklore, it has been enhanced in the course of time by new and even more touching features. First more attention was given to the Governor of Loxa to whom the Countess allegedly was indebted for the remedy. It was stated that it was Don Juan Lopez de Canizares, that his own cure from malaria took place in 1630 and—this is the new feature—that the mysterious drug was administered to him by an Indian *cacique.* Scientists like Charles-Marie de la Condamine, who was in Peru from 1736 to 1743, perpetuated the story of Bado, and the great Linné gave it his blessings by naming the botanical genus "*Cinchona*" after the Countess, basing his new term on Bado's Italian spelling of the name which in correct Spanish reads Chinchon. Finally, in 1874, Sir Cl. R. Markham wrote an elaborate Memoir on the family of Chinchon in which he, without any evidence, dated the alleged cure of the Countess as 1638 and identified the heroine of the story as Ana de Osorio who married the Count of Chinchon on August 11, 1621. Markham furthermore added another detail, namely that the Countess on her return to Spain "administered Peruvian bark to the sufferers from tertian agues on her lord's estates, in the fertile but unhealthy *vegas* of the Tagus, the Jarama, and the Tajuna. She thus spread blessings around her and her good deeds are even now remembered by the people of Chinchon and Colmenar in local traditions."

This touching story is based entirely on reports received by Sir Markham from the administrator of Chinchon who himself related "local traditions" without any documentary proof whatsoever. It is understood that such "information" cannot be regarded as a very reliable source.

Nevertheless, in 1930 the story of the cure of the Countess of Chinchon, with all its embellishments, was generally believed with the only change that now the second and not the first wife of the Count was thought to have been the heroine. The likewise very dubious story of Don Juan Lopez de Canizares, Governor of Loxa, having been the first European to be cured through the use of *Cinchona* bark was even made the basis of a *Cinchona* Tercentenary celebration that, in 1930, was observed all over the civilized world.

It was Henry S. Wellcome, born in 1853 in Almond, Wisconsin, U.S.A., as the son of an itinerant missionary preaching among the Indians, and at the time of his death in 1936 an English baronet and the head of one of the world's biggest pharmaceutical houses, who initiated the observance of this celebration and arranged a unique *Cinchona* exhibition within another unique creation of his, the Wellcome Historical Museum, in London. Although this celebration was based on historically uncertain ground, the world of science has all reason to be grateful for it. At no other time and occasion would it have been possible to collect and secure so much valuable material concerning the history of, and the scientific work done on, *Cinchona*.

If there were such a readiness even in the world of science to submit to the allurement of a touching story, what could be expected from the laymen? Thus there appeared reports and finally novels and plays that gave the story still another turn, making it a dramatic event in the relations between the Indians and the Spanish conquerors. Now it was not the Governor of Loxa who, cured by the benevolence of an Indian, conveyed the miraculous drug to the Countess of Chinchon, but there was a direct relation between the Indians and the wife of the Viceroy of Peru. A story of this kind was written by a female Dutch novelist, Madame de Genlis, about 1800. It was dramatized by Jan de Quack whose play was published in 1819 under the title *Zuma, Of De Ontdekking van den Kina-Bast*. The legend of the first use of *Cinchona* bark by Europeans had reached its sentimental and sensational climax.

Enmity prevailed between the Inca and the representative of the conquerors, the Count of Chinchon. The Spaniards died from tertian fever by the hundreds while the Inca, having the means to cure them in his hands, observed the death of his enemies with diabolic pleasure. Then the Countess herself, the wife of his main adversary, was stricken with the illness and her death seemed to be unavoidable. In this moment Zuma, the daughter of the Inca, who secretly adhered to the Christian faith felt herself compelled to help. She furnished the Countess with the powdered bark of *Cinchona*, the Countess immediately recovered, and the play of Jan de Quack closed with a splendid scene of fraternization between the Spaniards and the Indians. There are frescos in the pharmacy of the S. Spirito Hospital at Rome of an apparently earlier period picturing the delivery of the *Cinchona* bark to the Count of Chinchon and his administration of the life-saving potion to his Countess.

It was in the same year in which the *Cinchona* Tercentenary Celebration spread all these stories once more all over the world that a discovery was made which once and forever deprived the romantic texture woven about the first use of *Cinchona* by Europeans of its historical fundamentals. The irony of history made the same man who had initiated the celebration the initiator of this discovery. It was in behalf of Sir Henry S. Wellcome that Miss I. A. Wright undertook the research in the Sevillian *Archivo Generale de Indias* in the course of which she found the official diary of the Count of Chinchon relating to his term of office as Viceroy of Peru and meticulously reporting every detail in the life of the Count and his family. A. W. Haggis to whom the world of science is indebted for his masterly investigation and clarification of the history of *Cinchona* published in the *Bulletin of the History of Medicine* (vol. X, 1941) concludes:

2. That the absence of any mention of the remedy or of any serious illness of the Countess in the official

Diary of the Count of Chinchon strongly suggests that the romantic story of the cure of the Countess by *Cinchona* is no more than a fable. 3. That she never returned to Spain, but died at Carthagena, Colombia, on 14 January 1641, and so could never have brought the remedy to Europe, nor distributed it to the poor of her native country.

Thus, the touching story of the part of the Countess of Chinchon in the discovery of the medicinal qualities of *Cinchona* bark exploded about three hundred years after it was reported for the first time.

But was there not still another possibility? Since it was proven beyond any doubt that the Countess could not have been the heroine, what about the Count as the hero? It may be that only the roles of the two had been confused, that she helped him to the life-saving drug instead of him doing that to her. It speaks for the immortality of well-told legends that this version forms indeed the last line of defense of those whose hearts long for romance as an integral part of life. True, the Diary of the Count in reporting the attempts to fight the fevers from which he was suffering tells only of bleeding and purging and there is not the slightest intimation of a new and miraculous drug like *Cinchona*. But could not the whole thing have happened nonetheless, maybe after the termination of the Dairy and, above all, were there not other events or considerations offering at least circumstantial evidence?

In his book *La Introduccion de la Quina en Terapeutica* published in Mexico in 1941, the eminent Peruvian historian of medicine, Dr. Carlos Enrique Paz Soldán, tries to furnish this evidence. He refers to the report of "a credible historian" telling that "having received marked favor from Our Lady of the Prado, the Count of Chinchon decided to erect her a church and gave for this purpose 80,000 pesos," and later on sent to the Virgin from Cartagena other gifts valued at 100,000 pesos. In the opinion of Dr. Soldán these extraordinary donations have to be linked with the greatest events in the life of the Count: his improved health since 1638 and the death of the Countess in Cartagena (1641).

The following quotations from the book of Soldán are taken from the translation rendered by Georgianna Simmons Gittinger and published in the *American Journal of Pharmaceutical Education* (vol. VIII, 1944, January):

> Who cannot see . . . that the most solemn and extraordinary part of his [the Count's] life in Lima, [says the eloquent Soldán,] was to find himself free of the implacable malarial relapses. . . . How can we fail to believe that this fact was not due to the medicine of his doctors but to the bark sent from distant lands. . . . How can we doubt that if he took the quina, a therapeutic adventure then, he did it on the counsel of his faithful wife, unselfish and devoted nurse to whom was sent the precious unknown substance?
>
> There were Don Juan de Vega and his colleagues who for years supported the Count with their Latin aphorisms and their lancets diminishing by daily bleedings the strength of his organism. How could they view the liberating quina other than something supernatural?
>
> The miracle happened and all had to accept it.

These sentences are beautiful, but they put sentiment in the place of evidence. They do not explain why there was no mention of the wonder bark as the source of the miracle, and donations to the church by wealthy persons were too frequent in the times concerned to be taken as proof for extraordinary events causing them.

Do we really have to accept the miracle? This question may well be answered in the affirmative if we rise to the concept that the miracle lies just in the so-called natural course of life and not in the supernatural, in truth and not in fancy.

AN ANTHROPOLOGICAL CAMPAIGN ON AMCHITKA*

By CAPTAIN PAUL GUGGENHEIM

MEDICAL CORPS, ARMY AIR FORCES

ARMY life in the Aleutian Islands is different from army life anywhere else in the world. It is unsurpassed for loneliness, isolation, and foul weather. Spending a summer there on an expedition is romantic, but the deadly routine of military duty gives the islands the aspect of a Siberian prison. There are no natives (since the war), absolutely no feminine society, and only the most primitive of physical comforts. The islands are not without an awesome, primeval beauty with their magnificent volcanoes and rolling, treeless hills, although somewhat the worse for military occupation, which everywhere raises mud and banishes the life of the earth.

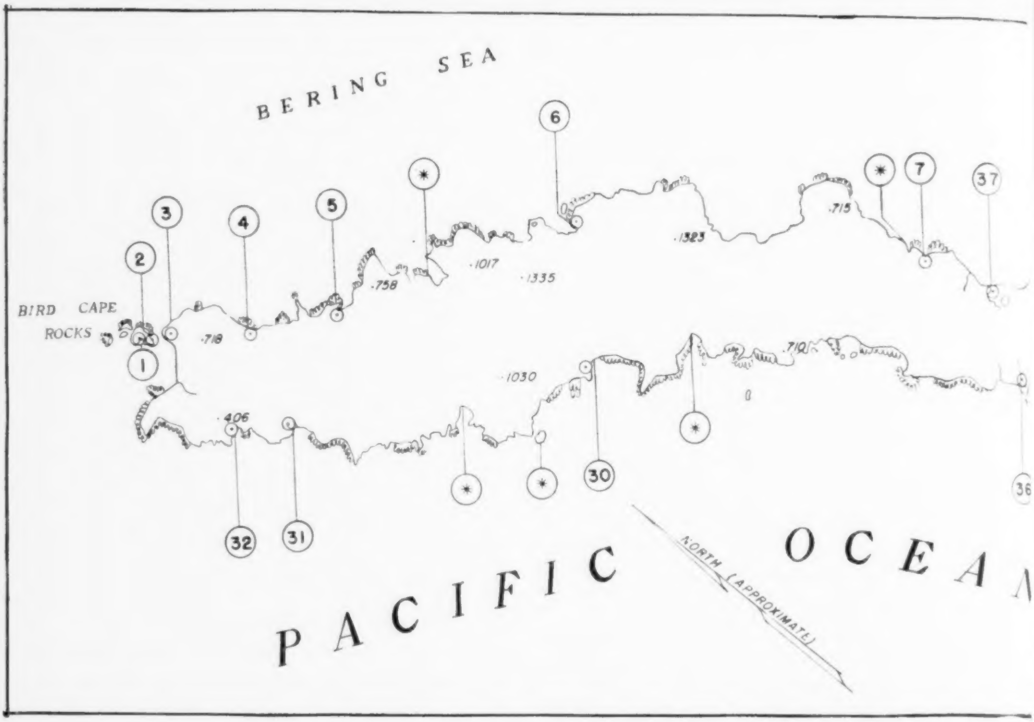
* The author acknowledges with gratitude the assistance rendered in the work here reported upon by many persons whose names will not be repeated throughout this account. They are: T/Sgt. Ralph Tierney and M/Sgt. John Hornbeck, who discovered site 9; Lt. Berniece L. Garner, who reported sites 11, 12, 13, 14, and 26; Capt. Niel Ritchie, who independently discovered and worked site 13 (Pistol Lake); M/Sgt. Frank Penn, who reported site 27; officers and men of my old outfit: Capt. O. E. Hanes, M. C., Capt. Dick Maskal, D. C., S/Sgt. Dick Laskey, Cpl. Dalton Pile, Pvt. Edmund Highlander, Pfc. Lester Brown, Cpl. Willie Briggs, Pvt. Frank Muller, M/Sgt. Opie Wellborn, Sgt. Jerry Van Rensaeller, and the indefatigable Cpl. René Wendell, who discovered sites 17 and 18; Cpl. George Frazier; Capt. Dean T. Henry and M/Sgt. Clark W. Bowman, who did valuable work on the Clevenger-Makarius site (25); Pvt. Michael Koker, who was the authority on site 10; Cpl. George A. Blahuta; Lt. James W. Graves; S/Sgt. Bayless Blake, who discovered site 29; Cpl. Russell E. Hemmingway and Sgt. Niel Stinner, who showed me the first Aleut skulls (from site 29); Capt. Bryan Ralph Hoover; Lt. Lewis Turner; Cpl. Joseph Ernest; Lt. Donald Arnold; Lt. Bill Pearson, post special-service officer who acted as central coordinator; Lt. Ray Van Slyke; Cpl. Carleton King; Sgt. Bob Ruelle; Capt. Richard D. Rucker, D. C.,; Pvt. Lee Malone; Lt. Robert Jones; Sgt. Jerry Ippolito; Lt. (j.g.) Paul Griffeths and Lt. (j.g.) Marcus Stoddard; Capt. Ralph DeBit, M. C.; Lt. Noble Drennen; Capt. (Chaplain) Henry Zenter, who reported site 22; Capt. Seaholtz, who reported site 19; Pvt. Tope, who excavated the wonderful war club from site 28; three civilians of the West Construction Company who did much work on Dr. Hrdlička's old site: Hans Mross, Tom Hinchy, and Bill Hunt; and finally my faithful helpmate, Lt. Col. Delmar R. Hughes, who assisted with extensive work on this same site.

Winter and snow greatly improve the appearance of the regions occupied by the troops. Not until I had spent a winter in the Aleutians did I appreciate a certain antinaturalistic and, to me, repugnant line in Milton's hymn *On the Morning of Christ's Nativity*, which refers to snow covering the "foul deformities" of nature.

Amchitka is one of the major islands of the Rat group, lying near the 180th meridian. Before the taking of Attu and Kiska it was our most advanced Aleutian base. I landed there on May 1, 1943, my twenty-eighth birthday. Although I was part of a busy tactical organization, for me, a mere medical officer, the campaign was largely an affair of *Sitzkrieg*. I could not help thinking what a coincidence it was—my being in the Aleutians again. I had been with Dr. Aleš Hrdlička in 1937 on the Smithsonian Aleutian Expedition and had noted in my journal: "Our trip may be just a prewar interlude." War clouds hung heavily over the world that summer, but little did I dream that I would return six years later as a soldier. Being on Amchitka now, I thought, afforded a rare opportunity to do some scientific work, for the island was anthropologically unexplored, except for the region of Constantine Harbor, which Dr. Hrdlička investigated in the summer of 1938. In his report of that summer's work one paragraph was devoted to Amchitka:

> The next stop was on the island of Amchitka. After a stormy night on the little *Ariadne* we were put off in Constantine Harbor, where there are a couple of small houses recently constructed by the Bureau of Fisheries and four native trapper dwellings, with an attractive little native church. There are no inhabitants on the island in summer. We found here two good sites, largely pre-Aleut, and had three weeks of assiduous excavation. This yielded, aside from a variety of cultural objects, several of the oblong headed pre-Aleut skeletons, and, deep in the deposits, the first specimens found in these parts of the world of well wrought deep stone pots and dishes.

I had been corresponding with Dr. Hrdlička, but not until the end of the Attu-Kiska campaign was I able to tell him that

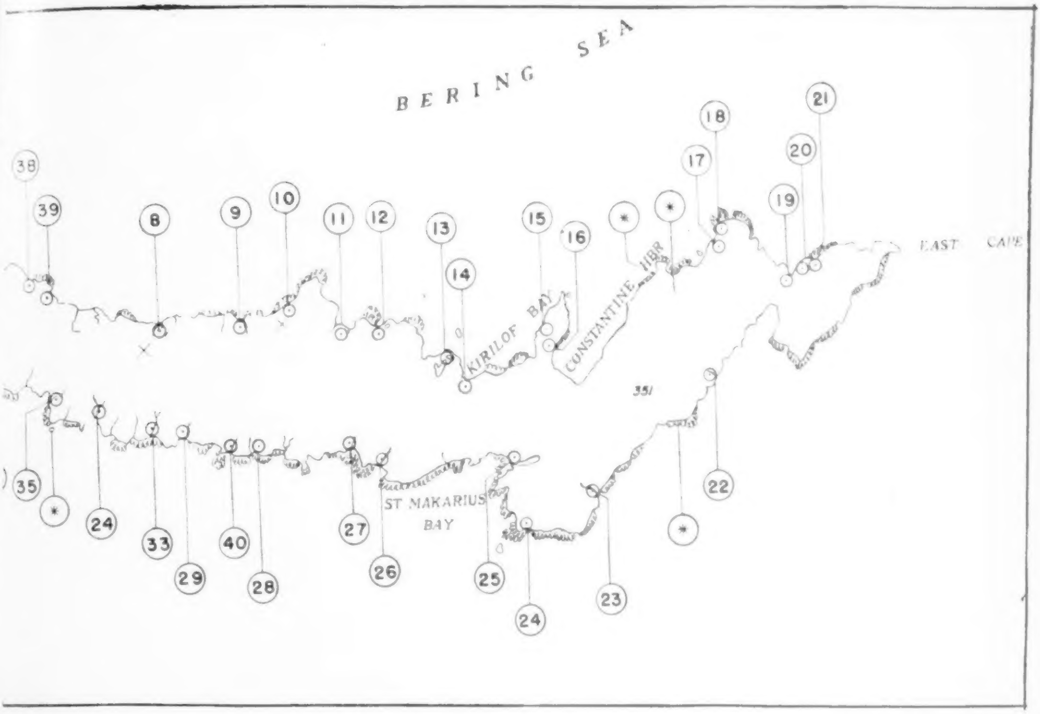


PREHISTORIC VILLAGE SITES

SITES ARE NUMBERED CLOCKWISE AROUND THE ISLAND BEGINNING ON BIRD CAPE, EXCEPT NOS. 33–40, WHICH

I was in the Aleutians again. He was most encouraging and wrote many letters exhorting me to make investigations and report the results to him. He died on September 5, 1943, before I returned to the States.

Administrative difficulties. Owing to the tactical situation and to the fact that I had no official status as an anthropologist, I wrote to the commanding general of the island requesting permission to reconnoitre the island and excavate archeological sites. This was granted, but many difficulties arose. Diaries were not permitted, and so what records I was able to keep were mostly fragmentary and vague. We were not allowed to stake off sites or erect signs. Worst of all, there was no way to control the vandalism of casual collectors. Without orders from Washington the general rightfully deemed it inadvisable to place excavation under rigid military control. In a misguided effort to encourage a scientific approach the Force Headquarters issued several memoranda containing my suggestions for making excavations in an orderly and scientific manner. These publications served to create a widespread interest among both officers and enlisted men. "Digging" reached almost epidemic proportions. Needless to say, scientific procedures were not followed. It was every man for himself, using the foxhole technique. At no time during my stay on the island was it possible to do any extensive, systematic excavating without "sabotage." Repeatedly I spent days or weeks making a beautiful exposure on some quiet, isolated site, only to have it tumbled down and filled in by poachers. It was foolish to become embittered over this, for "souvenir hunting" did provide an interesting and profitable outlet for the "prisoners of Amchitka." But realizing how little could be done without more support from higher up, I kept writing to Washington urging that advantage be taken of the unique opportunity offered by the military occupation of the Aleutians to conduct widespread anthropological investigations and describing the practical difficulties caused by the soldiers' depredations. In February 1944 the



ON THE ISLAND OF AMCHITKA
WERE INTERPOLATED AFTER THE OTHERS WERE NUMBERED. THE *asterisks* DESIGNATE PROBABLE VILLAGE SITES.

National Research Council brought the matter to the attention of the War Department, and an order was issued by Headquarters of the Alaskan Department proscribing indiscriminate excavating by military personnel, invoking the Antiquities Act of 1906. Some provisions were made for the collection of specimens unearthed in the process of necessary military excavation, but no program for carrying out deliberate scientific work was mentioned.

General Description of the Island. Amchitka is a long, slender island, approximately thirty-three miles in length and nowhere much wider than two and a half miles, so that in many places one can view the Pacific and the Bering simultaneously. The western part is hilly, and there is a low range of weird-looking mountains whose desolateness suggests a Doré illustration of Dante's Inferno. The central and eastern parts are flat. The coast is rugged, with hills or cliffs dropping directly into the sea or overhanging scant, rocky beaches. The hills are separated by draws or defiles, which begin some distance inland and run down toward the sea. Streams, many of them subterranean, run in some of these draws. There are many small, fresh-water lakes, especially in the central and eastern portions of the island. The flat part is covered for the most part by muskeg. Tundra is not so common. The old village sites are almost invariably covered by tundra, which can be distinguished from a considerable distance away because of its coarser texture and deeper color. Without exception the sites are located on the coast.

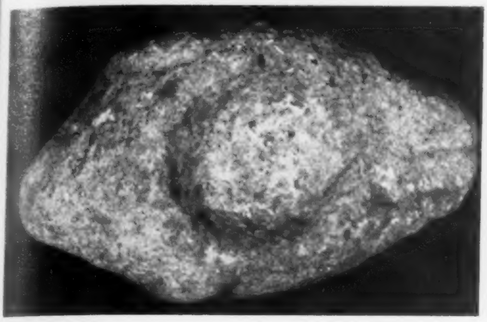
Amchitka is one of the great breeding grounds of the sea otter. There are many birds—chiefly gulls and other sea birds, ptarmigans, and enormous black ravens. In summer there are many wild flowers growing in the muskeg. The island is notoriously foggy, even by Aleutian standards.

During my ten months on Amchitka I had opportunity to explore much of the island personally. Many of the archeological sites, however, were discovered by others and reported to me. I gathered information from

CLEVENGER–MAKARIUS SITE (NO. 25), SHOWING EFFECTS OF INDISCRIMINATE DIGGING

all available sources, making innumerable trips to explore new sites, interviewing soldiers, and examining their collections. It was usually a simple matter to determine the exact locations of the sites, by using the 1,000-yard grid map of the U. S. Army Engineers. Some of the sites have been named after their discoverers or other individuals prominently associated with them. In all, forty sites were catalogued (see map). The more interesting of these will be described in the following pages, along with some experiences and finds. It should not be forgotten that our archeological operations on Amchitka were fragmentary, constantly interrupted, and, in general, conducted on a "catch-as-catch-can" basis. Many men participated at various times (see footnote, page 21).

Clevenger-Makarius-Pacific Site (No. 25). On May 18, with two companions, I made my first reconnaissance hike. We headed down to St. Makarius Bay and at the bottom of it came upon a stream draining a large lake (Clevenger). There was a village site occupying both banks. Facing away from the Pacific, the right or east bank presented a flat appearance and could hardly be called a midden, but on the left or west bank was a good-sized midden. The stream and its site lay in a narrow valley that broadened out inland toward the lake. On the east was higher ground. To the west the site extended from the midden up onto some high cliffs for a considerable distance. On the midden were two habitable barabaras, one fairly large, in which some enlisted men were living. There was also a little, one-room, gray, frame house (since destroyed) built by the Bureau of Fisheries. Depressions left



STONE LAMP FROM SITE NO. 25
PROBABLY FROM A DEEP LAYER. NOTE THAT IT IS IN FORM OF SEAL PUP—MOUTH, FLIPPERS, TAIL VISIBLE.

by old barabaras were evident in various places on the midden. In the stream below were pieces of the skeleton of a large whale. We began to excavate the midden on the side facing the stream.

The inhabitants of the barabara agreed not to disturb our exposure. In a short time, however, everyone in that part of the island seemed to know of the site, and on good days it was actively vandalized by as many as thirty persons at a time, ranging from privates to lieutenant colonels. In working there with our medics I gradually rediscovered the pleasurable sensations of performing certain archeological motions—tumbling down muskegs, undercutting, floor-sweeping, picking in the shell deposits. It made me feel as if something long dormant was awaking to life. The desert bloomed, and I forgot about the war.

Late in June I received a phone call from Capt. Dean Henry, a former Missouri school teacher, who invited me over to dinner and presented me with a fine skeleton that he had excavated from the northern side of the midden, 4 feet beneath the muskeg. "Oscar," as we called him, was a long-headed male, stretched out in a casual position in deposits of greenish shell mixed with dirt. Some bone harpoon points were found near him. This represented a moderately deep, but not the deepest, deposit. Not long afterward "Mable" was found. She was a long-headed, rather horse-faced female and was uncovered near a barabara just beneath the muskeg on the flat side east of the stream. She lay in the knee-chest position, on, but not in, the shell deposit. Nearby was a badly shattered cranium ("Mable's friend"). In August another soldier contributed the complete skeleton of a young infant from the deepest layer of the midden. Both fontanels were open; the cortex of the right mastoid tip was gone, and one could view some large cells within. It is possible that this infant died of mastoiditis with a Bezhold's abscess.

All the skulls found in this site were long-headed and therefore probably pre-Aleut. I saw no brachycephalic skulls corresponding to the Aleut post-Russian culture, later discovered on the west bank. The site is probably an old pre-Aleut one, with a thin overlay of post-Russian culture in the midden. This excellent site was literally torn to pieces by the soldiers, and many skeletons were scattered and lost.

Most unique of the cultural objects found in the Clevenger-Makarius site were fine ivory needles, which so far as I know were collected nowhere else on the island. They were of various lengths. The commoner type had a groove at one end around which the thread was tied. Of rarer occurrence was a needle having a minute but perfect eye for threading. Occasionally a double-pointed needle (toothpick) was found. Other objects included two unique stone lamps, carved in

PESTLE AND STONE LAMP
FOUND TOGETHER IN THE DEEPER LAYERS OF THE CLEVENGER-MAKARIUS SITE (NO. 25) ON AMCHITKA.

VIEW OF KIRILOF CLIFF SITE (NO. 16)

the form of a seal's head and a complete seal pup; carved links of a bracelet or necklace; a finely tooled shard, apparently part of a dish or lamp; polished stone knives; bone wedges; and a beautiful little ivory dolphin, evidently worn as a pendant. The existence of a thin overlay of post-Russian culture in the midden of the west bank was demonstrated in January 1944 by Cpl. René Wendell, of Pittsfield, Mass., who found in the superficial layers of the midden several bone knife handles with rusty copper blades (much patina). He also had some round, glass, blue-and-white beads that a friend had found there.

During the winter, excavation was difficult because of the frozen ground. I visited the site occasionally, poking about, but it was a shambles. The yield of specimens, once rich, showed signs of exhaustion. Undoubtedly, however, work could still be done there under favorable conditions.

Kirilof Cliff Site, Constantine (No. 16). On May 20 I set out with two other soldiers to locate the two sites that were described by Dr. Hrdlička in 1938. We approached Kirilof peninsula from the harbor side and found a large site perched on the first cliff overlooking the harbor. This, we presumed, was Dr. Hrdlička's "Hill Site." Part of the cliff had been blasted away in road building, and there was no sign of any scientific excavation. We found, however, that three civilians had been working the site, and though they used the foxhole method of digging they were careful, diligent workers. They had exhumed several skeletons and had showed them to medical officers at the station hospital, who, I was told, did not know what to make of them. The civilians, therefore, thinking that the skeletons were valueless, discarded them. I explained to them the significance of their finds and they were keenly interested, showing me their beautiful collections of artifacts. They had much carved ivory and a number of beautiful labrettes, some larger than any I had seen in 1937.

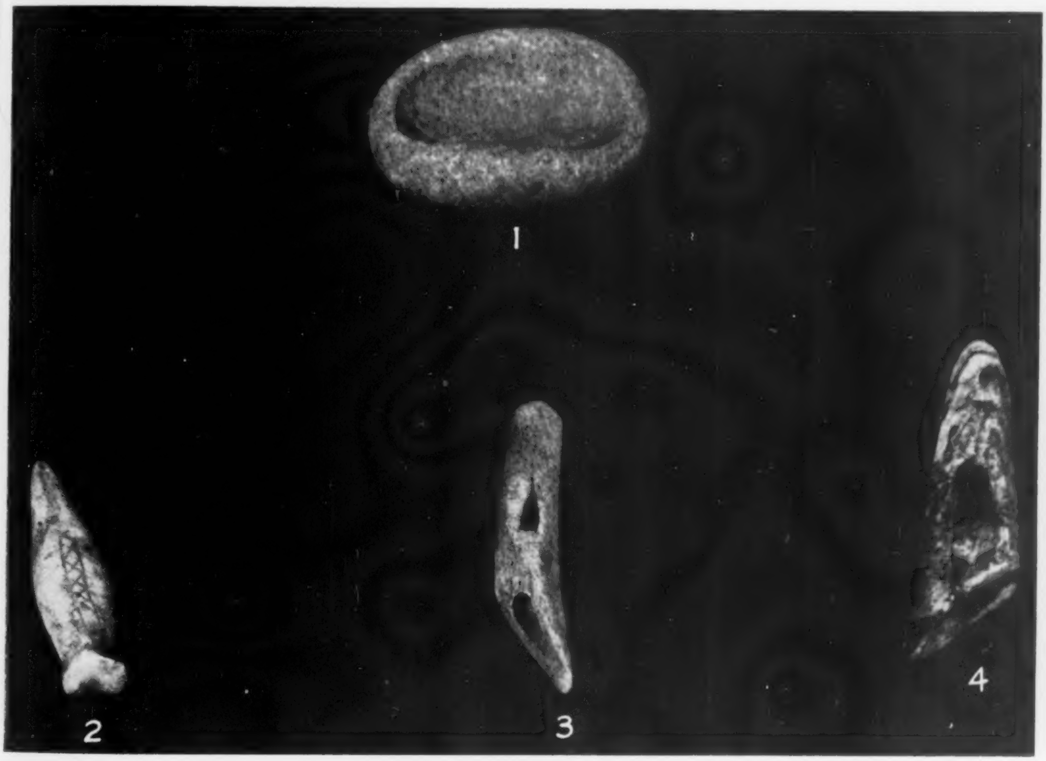
On Memorial Day we began to work the cliff site and the next day found two interesting specimens: one an elaborately carved awl or sewing instrument of fossil ivory and the other a tiny stone lamp. This lamp was the smallest one I had ever seen, measuring only $2\frac{1}{2}$ by $1\frac{3}{4}$ inches. We called it our "5-watt night light." The sewing instrument was one of the finest pieces found on

the island. As we worked that day we witnessed the burial of the post inspector who had been killed in a vehicle accident. One could not help an embarrassing sense of the bizarre cycle here being enacted as we interrupted our unearthing activities to stand at attention while the coffin was interred.

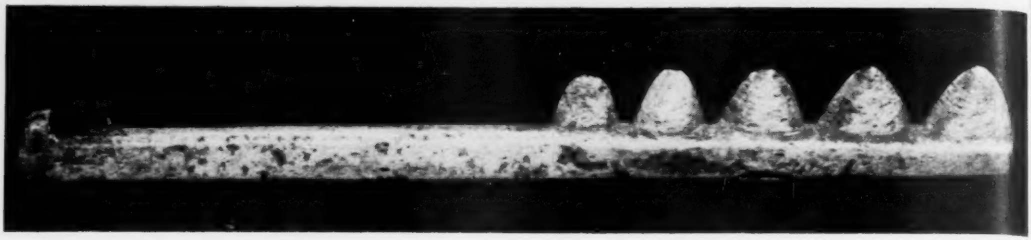
Late in the summer and fall my faithful companion Lt. Col. Delmar Hughes and I worked this cliff site nearly every evening after supper. We managed to start a fairly extensive excavation, but late in the fall poachers destroyed our work and thereafter we limited ourselves to "poking about." To complete our discouragement some sailors one day dug up an ivory doll made from a sperm-whale tooth, and this was their first visit to the site! The colonel seemed to have considerable luck picking up artifacts, many of them very fine ones, along the beach. His private collection was one of the finest on the island.

Exploring the Central Portion of the Island. Several other promising sites were located on the Bering side of the island. One evening our mess sergeant and I set out for a site (No. 9) which was only about three-quarters of a mile from camp and in which 14 skeletons were reported to be lying exposed. We rounded one point on the Bering and came upon a huge green midden almost filling the bottom of a fair-sized bay. There were many barabara holes, and in one particularly large one were the skeletons. Unfortunately someone had taken two-thirds of them and left the rest scattered about in utter confusion. I sorted them as best I could.

Though I was never able to start anything systematic at this site, I managed to buy some fine artifacts from some of the men who had merely scratched the surface and been rewarded by a virtual shower of specimens. These came from the barabaras. There were some very long bone harpoon



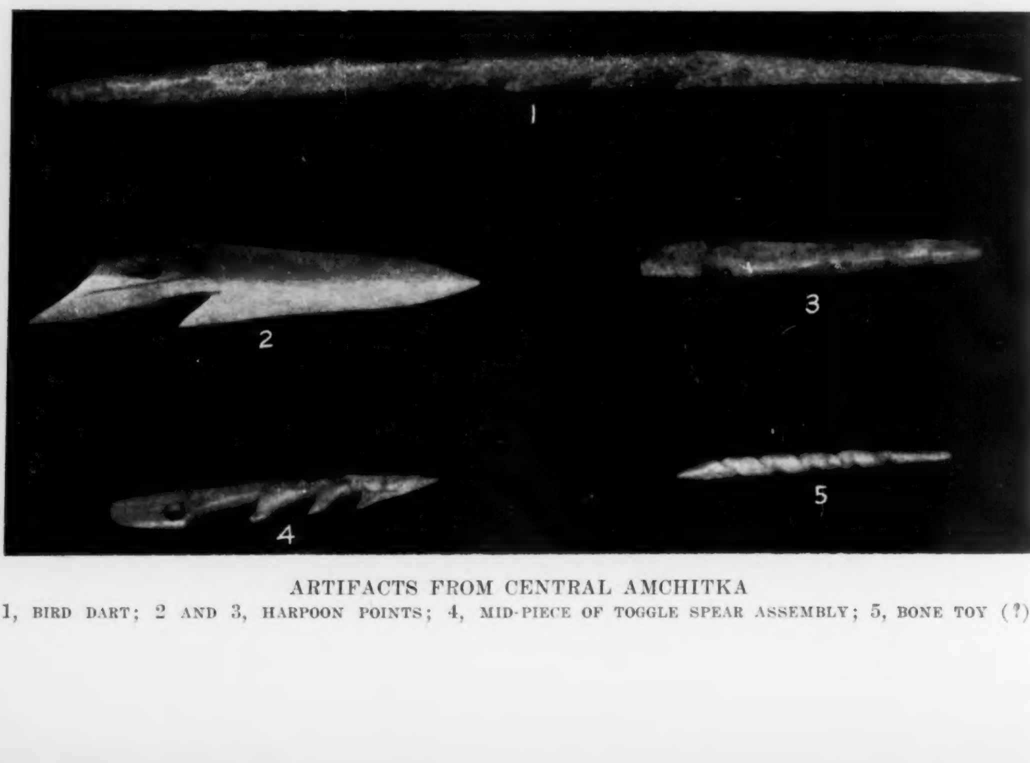
AMCHITKA ARTIFACTS
1, TINY STONE LAMP FROM KIRILOF CLIFF SITE (NO. 16); 2, IVORY CARVING RESEMBLING A FISH HEAD; 3 AND 4, FOREPIECES OF A TOGGLE HARPOON ASSEMBLY. SOLDIERS FOUND, BOUGHT, AND SOLD SUCH ARTIFACTS.



WAR CLUB FOUND AT BOTTOM OF SITE NO. 28
REPRESENTING THE VERY ANCIENT PRE-ALEUT CULTURE. MADE OF A BONE OF A WHALE AND HIGHLY POLISHED.

points, measuring up to 1¾ feet; shorter harpoons and bird darts; and an interesting midpiece of a spear, made of ivorylike bone and perfectly split in the longitudinal axis, the two halves being designed to be tied together by thongs. [Interestingly enough, I later acquired an identical object from site No. 28 directly across the island from No. 9. With it came what is probably the finest object ever found on Amchitka—a highly polished, finely worked, and very lethal war club about 1¾ feet long, made of dense, partly mineralized bone of a whale and having five vicious teeth of graduated size. This was found at the bottom of a hole 16 feet deep dug at the edge of the site adjacent to the Pacific, extending down through all layers of the deposits into dirt and rock. It is, therefore, undoubtedly very ancient.]

In August I spent a day at Pistol Lake site (No. 13), a picturesque spot on the Bering Sea. The lake and its site lay at the end of a sloping valley and could be seen from far inland. The soldiers had dotted the place with foxholes. In the evening I gave a lecture to the men on archeological matters, but having given several previous lectures I was becoming very skeptical about the value of my educational efforts, which seemed only to encourage more vandalism without yielding any material for the collection. The soldiers were always keenly interested but clung possessively to their bones in most instances. It was not unusual to see skulls, with eye and nasal sockets painted red, adorning tent posts on Amchitka, and to me it was a painful sight even though it furnished some amusement.



ARTIFACTS FROM CENTRAL AMCHITKA
1, BIRD DART; 2 AND 3, HARPOON POINTS; 4, MID-PIECE OF TOGGLE SPEAR ASSEMBLY; 5, BONE TOY (?).

EXCAVATING AT BIRD CAPE

Bird Cape (Nos. 1–3). The community at Bird Cape was something a little out of this world. The scenery there is the grandest on the island. The narrow coastal lowland is sandy, a welcome relief from the ever-present mud. Just inland great hills arise, farther eastward passing into a range of mountains. One great hill, which dominates the cape itself, is of the truncated mesa type, a formation most unusual in the Aleutians but characteristic of the Commander Islands.

My first visit to the Cape was in the latter part of July, and during the four days I was there the weather was beautiful and sunny—a remarkably rare phenomenon. The region was utterly peaceful and idyllic. The view to the westward was magnificent, with four volcanic islands visible and on very clear days a fifth—Kiska. Every day as I excavated on site 3 the Kiska bombing missions flew over, reminding me that after all there was a war going on. On July 22 Kiska was shelled by our battleships. The great salvos shook the earth, even where I stood. The peacefulness of Bird Cape in the midst of all this was bizarre and incongruous. My excavations during this period yielded the complete skeleton of a child about six, at a depth of only 2 feet. I found also polished stone knives, stone lamps, and two very interesting double rubbing stones, which are supposed to be a cultural link with the tribes of northeastern Siberia.

In October I was able to return to the Cape for a five-week stay. I lived at the "country club," an elegant barabara that was really a subterranean log cabin. We had a fine radio and running water, hot and cold. The club has since been lined with celotex and furnished with a real porcelain wash basin and a shower. The local "elite" lived there, which always included the resident medical officer and two of the permanent party. It was the social center, and it was built on the edge of site No. 3—an ideal arrangement. I spent my leisure time excavating a long cor-

DOUBLE-HEADED (JANUS) DOLL

FROM LOWEST DEPTHS ($5\frac{1}{2}$ FEET) OF SITE NO. 40, EVIDENTLY AN ALEUT SITE AND SHOWING EVIDENCES OF POST-RUSSIAN CULTURE. DOLL SHOWN IN SIDE VIEW.

IVORY DOLL
CARVED FROM TOOTH OF SPERM WHALE. SITE NO. 29.

ridor about 6 feet wide, from the sea inward, in an effort to work my way completely across the site. I got perhaps a third of the way through, having arrived on the threshold of a barabara hole.

At the end of October we had a hurricane, and the day after the storm we crossed the Bird Cape channel in an amphibian and landed on the Rocks (Fox Island) to conduct some salvage operations on a wrecked ship, the crew of which got safely ashore. I took the opportunity to reconnoitre the island and found two sites (Nos. 1 and 2). No. 2 was the best one and was exactly opposite No. 3 across the channel and may have been occupied contemporaneously with it. Site No. 1 was on a narrow spit of land between a small fresh-water lake and the ocean. I made several trips thereafter to the Rock to work site No. 2 and found a few artifacts but no skeletons. The site may still be considered practically virgin. It was dotted by a great many square barabara holes, one next to another, in the centers of which were clusters of dried stalks of some tall flower resembling a sunflower. My little excavation faced the channel and may possibly still be visible from the Cape where I saw it stand out against both green tundra and winter snow.

I returned from the Cape on November 17 and, after this diversion, was glad to be back with my squadron. The snow had arrived while I was away, and I was amazed at the difference in appearance of our part of the island. Christmas was already in the air.

The Hobby Fair; Traffic in Specimens. In January we had a hobby fair on the island, sponsored by the commanding general. To my surprise there were many unusual exhibits of archeological specimens. First prize was won by an organization with about a dozen such displays. Our squadron won second prize. The fair gave me a chance to meet many men, hitherto unknown to me, who were successful diggers. Many of them were soon returning to the States and were willing to sell me some of their artifacts. If the reader wonders why so many specimens were acquired by gift or purchase, the reason is not far to seek. When, as was usually the case, I was unable to excavate properly without interference from poachers, I confined my activities to reconnaissance and inspection of the workings of others. Many soldiers had much better opportunities than I to work isolated sites intensively, and it is not surprising that some of them accumulated really remarkable collections. Furthermore, since money could not be spent in ordinary ways on Amchitka and since the men were reluctant to part with their prized artifacts on a donation basis, I invested over a considerable period of time about $500 in specimens that

PISTOL LAKE SITE (NO. 13), POCK-MARKED WITH FOXHOLES

otherwise would have been scattered and lost. My personal collection largely consists of these purchased objects.

I could not bring myself, however, to buying skeletons, although some of the men got the idea that there might be a market for them. One day our mess sergeant showed me a fine dolichocephalic male skull he had obtained at site No. 25. He wanted $30 for it because of the unique fact that a stone point was completely embedded in it just behind the left orbit. I told him that I did not buy skeletons and did not consider it very Christianlike to traffic even in heathen bones. Later he reduced the price to $10, and again I declined, though very anxious to acquire the specimen. Finally he decided to send it home, and I asked permission to

AMCHITKA ISLAND—WINTER LANDSCAPE

A CORNER OF THE KIRILOF SITE (NO. 16) BEING EXCAVATED

borrow it in order to take some photographs. When I returned it, the sergeant broke down. "Gee, Doc," he said, "I haven't got the heart to keep it, knowing how bad you want it"; and he insisted on giving it to me despite my token resistance.

Concluding Days on Amchitka. Interestingly enough, it was only during my last month on Amchitka that evidences of Aleut occupation were forthcoming. All our previous finds had been pre-Aleut. A whole necklace of blue-and-white glass beads was found in site No. 17, east of Constantine Harbor, from a depth ranging from 1 to 3 feet. A harpoon head consisting of a rusty metal point held in a groove at the end of a bone piece about 6 inches long, was found in site No. 19 at a depth of 1 foot. From site No. 29, on the south side of the island, came five crania, three of them with mandibles, from 1 to 2 feet from the surface. These seemed to be unquestionably Aleut. Late in February I made a personal trip to this site and was further convinced that it represented Aleut and pre-Russian culture. It was an extensive site, beginning at the draw in the bottom of the inlet (see map) and extending along the whole western shore of the inlet. It is evident that there must have been an extensive occupation of Amchitka by Aleuts, although the dominant motif is pre-Aleut.

On March 6 I left the island, flying by way of Adak and Kodiak and reaching Seattle on March 28. Glad as I was to be home again, it was painful to leave my squadron and the dear friends who had shared so many privations and memorable experiences. As I have indicated, our archeological activities on the island were desultory and fragmentary, and it was not always possible to pursue them strictly according to scientific procedures. They showed, however, what might be done archeologically on Amchitka, as well as on other islands of the Aleutians. Most of our specimens have now found their way into the collections of the Smithsonian Institution, and when the history of man in Alaska is finally written it may be that our crude efforts will have contributed in some way.

THE PROBLEM OF THE AMAZON*

By F. FERREIRA NETTO

A...STANT GENERAL MANAGER, SERVICE OF AMAZON NAVIGATION AND ADMINISTRATION, PORT OF PARÁ, BRAZIL

[Translated by W. Andrew Archer]

THE REGION OF THE AMAZON RIVER BASIN

* TRANSLATOR'S NOTE.—This article by Lieutenant Netto, here presented in two installments, was first written primarily for Brazilians and was published in pamphlet form in Belém in 1942. Only 500 copies of the original Portuguese edition were issued, these mostly for official use and for local distribution to municipal offices. A mere 60 copies were offered for sale in Belém, and the pamphlet is now out of print. The present translation, therefore, seems justified, in order to bring to a wider reading public what seems to me a commendably clear and concise presentation of some of the facts concerning the great Amazon region.

In converting the original text into English I have taken considerable liberty in editing and rearranging sentences and paragraphs. A few sentences and one or two paragraphs have been omitted as not being of interest to North Americans. Furthermore, some of the scientific names of animals and plants have been revised to accord with usage in the United States. The original bibliography has been reorganized and complete citations given. These changes were made not from mere zealous dissension but rather in the hope that the resulting text would conform more nearly to English idiom and literary style.

In reviewing the section dealing with the fauna, Dr. Remington Kellogg, curator of mammals, U. S. National Museum, remarks, "The killing of white-tailed deer, brockets, and capybara for skins alone will result in the loss of the only available meat for the rubber hunters in the Upper Amazon. The trade in hides of these animals has reached such proportions that some notice should be taken and reference made to the need of some conservation measures. Possibly this can best be applied to the sale of such hides through commercial dealers."

In revising the plant names, Dr. S. F. Blake, of the U. S. Department of Agriculture, points out that the name *Nectandra puchiri* has not been located in the botanical literature. LeCointe refers the vernacular name "puchury" to two species, *Acrodiclidium puchury-major* and *Aniba puchury-minor*, but it is not possible at present to determine if the name as used by Netto applies to only one or both of these. Dr. Blake further indicates that the name "jarina" applies also to *Yarina microcarpa*.

All footnotes have been added by the translator.

Gratitude is expressed to the various persons, both Brazilian and North American, who have assisted and encouraged this work. Among these have been: Dr. Felisberto Cardoso de Camargo, director of the Instituto Agronômico do Norte; Zito Brígido; Fred L. Downs; Dr. Norman Bekkedahl; Walter Mors; B. Y. Morrison; Francis B. Thorne; Ralph R. Shaw; Philip Leonard Green; Louis C. Nolan; Prof. Th. Dobzhansky; Marcus Childs; and Forrest Sherwood. Special acknowledgment is due to Drs. S. F. Blake, Rogers McVaugh, and D. S. Correll, of the Division of Plant Exploration and Introduction, U. S. Department of Agriculture, for revision of the plant names; and to Drs. Waldo L. Schmitt, Remington Kellogg, Leonard P. Schultz, Herbert Friedmann, and Doris M. Cochran, all of the Smithsonian Institution, for like service in checking the animal names.

Lieutenant Netto's work is dedicated to His Excellency, Dr. Getulio Dornellas Vargas, President of the Republic of Brazil, creator and director of the reclamation program of the Amazon region.—W.A.A.

INTRODUCTION

ELDORADO or Green Hell? The mere fact that these two contradictory terms exist to designate this vast region watered by the largest river system of the world indicates how little is known of the Amazon Valley. In reality careful observation reveals the impropriety of either of these frequently used terms. Even though the Amazon is not a place where life is easy for everybody, neither is it a reproduction of the realm where *Lasciate ogni speranza* was inscribed over the entrance. Natural riches exist, but they are not to be obtained without work. It is as possible to live there as in any other part of the world, provided that elemental hygienic measures are observed.

The area of this least-known and least-inhabited part of Brazil is nearly 1,235,000 square miles, or 40 percent of the entire country. This fact alone deserves special attention in this day of concern with the grave subject of living space. Never before has the region been so much in focus as now, owing to the perturbed conditions prevailing throughout the world; and the Federal Government has pledged itself to study the varied problems which heretofore have defied solution.

The literature of the Amazon is enormous and deals with the most diverse aspects of the region. But even this varied and abundant literature, both difficult and costly to acquire, will not give everyone a perfect and

ready knowledge of the situation, especially in these times of speed and haste.

This little essay, without pretensions, is meant to give a general review of the subject as well as to include some personal opinions, which are the fruit of long study and impartial analysis.

The Factors

Land. The fertility of the Amazon Valley has been the subject of praise since the time of Humboldt. The "future cellar of the world" is a set phrase customarily used in referring to this vast region. We are led to this inference upon viewing the exuberant vegetation which extends for thousands of miles. However, this characterization is somewhat exaggerated and needs to be refuted for the good of the region itself. The fertility of the Amazon is a relative term and applies at best only to the native and spontaneous vegetation. Not that there is a lack of humus or a favorable environment. The density of the forest at once demonstrates that these do exist, and in abundance, but for systematic agriculture a tangled and heterogeneous forest is a hindrance. When the forest is cut down and the soil exposed to the copious rains of the wet season, all the fertile organic matter disappears completely, leaving the soil depleted and subject to the sterilizing action of the rays of the equatorial sun. For this reason, in order to continue cultivation, it is necessary to use fertilizers and to follow scientific methods as the conditions require. One cannot trust solely to Nature to obtain that which must be got by hard work.

Hundreds of species of detrimental plants, easily disseminated, are waiting to invade and smother any sort of cultivation if there is the least lapse in the continuous diligence that is necessary.

The greater part of the Amazon Basin, geologically the result of alluvial deposits, has not yet reached the final phase of stability, and consequently erosion appears just as soon as the protective vegetation is removed. If lines were drawn uniting all the principal waterfalls or rapids found in the tributaries on both sides of the majestic Amazon River, we would have an exact outline of the primitive, internal sea of a remote age. This body of water, with the passage of time, was being slowly converted into land; a process that continues even today, tending to the final transformation of the Valley into vast plain some thousands of years from now.

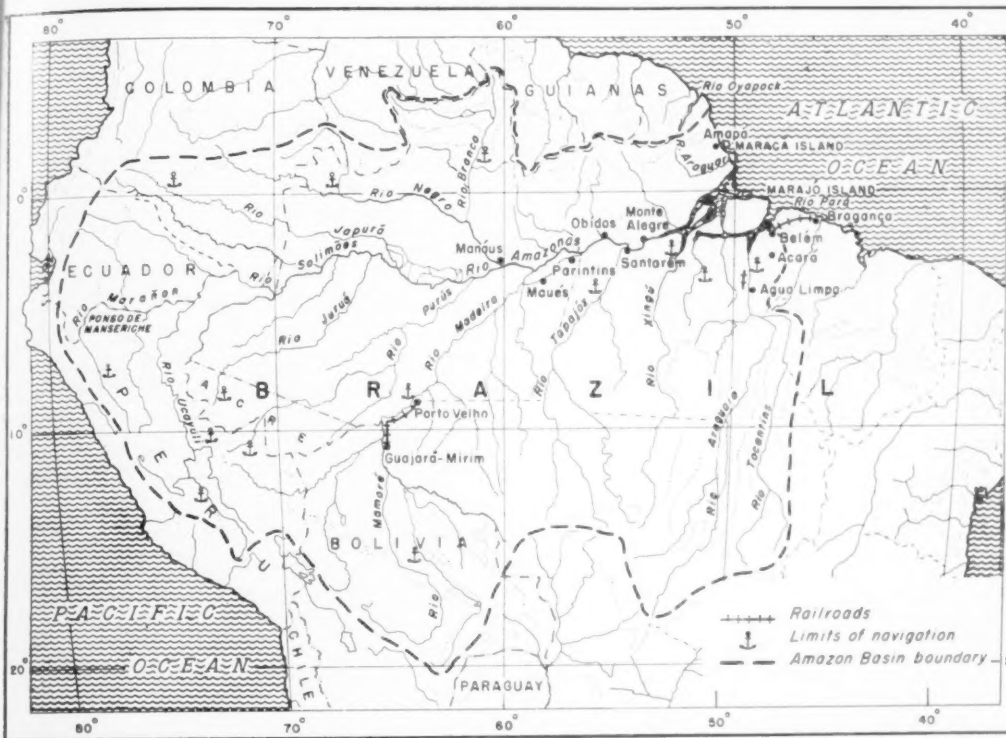
Several islands must have existed in that ancient, internal sea, but they have now been incorporated into the continent. Their vestiges are represented by the small elevations existing in the Lower Amazon region. Certain granite formations, sometimes isolated and surrounded by alluvial soils, as for example in the Bragantine region a few miles from Belém, undoubtedly have the same origin.

As yet no profound geological studies have been undertaken, but from the investigations already made the major part of the Amazon can be assigned to Cenozoic Era, while the marginal lands of most of the rivers, all the region of Purús, Jurúa, and Japurá, as well as the islands situated in the estuary of the Amazon River, belong to the Recent and the Pleistocene periods. Paleozoic and Proterozoic zones, about 30 miles wide, traverse the region from east to west, in the heights of the central portion of the Amazon, and to the south and north of this, between the meridians 51 and 60 W. of Greenwich. Contained in these zones are the elevations existing in the municipality of Monte Alegre, in the State of Pará, which are known in the regional literature under the names "Lookout of the Lower Amazon" and "Amazon amphitheatre."

Many parts of the Amazon are still unknown to white men and await future explorations, the principal of these being the headwaters of the Xingú and the Tapajós. These rivers, including the Tocantins, in the region of the waterfalls, traverse a zone characterized by crystalline formations, where gold and diamonds are found.

Aside from sandstone, and not considering the occurrence of granite, the probable origin of which has been already explained above, no rock is found in the entire Amazon Basin up to the first waterfalls, this being equally true in the north and in the south and the east, where the slopes of the great Guiana, Brazilian, and Andean massifs begin.

This enormous drainage area, reaching



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THE REGION OF THE AMAZON RIVER BASIN

some points nearly 3,000 miles away, daily discharges thousands of tons of earth into the river. The eroded material carried into the ocean produces new accretions of land during the course of centuries. This is most pronounced in the vicinity of the north coast, between the Island of Maracá and the continent, where ships of more than 5 feet draft cannot pass, even at high tide, although they could do so only a few years ago.

Innumerable islands are in constant formation along the entire extension of the Amazon River, new land being formed by the slow accumulation of deposits carried by the current.

Seeing the outline of the river and its principal tributaries on a map does not give one a very good picture of the actuality because nearly all the watercourses that discharge into the Amazon are united with one another by a network of channels and creeks forming a veritable labyrinth. A multitude of lakes exists along all the lesser rivers, especially in the middle portion of the river-ocean.[1] There is almost as much water as land, and enormous portions of land are covered for a part of the year by shallow water, forming what are called locally *igapó*.

The margins of the rivers may consist of banks, which are being slowly eroded, but usually they are beaches of thick mud, covered by a characteristic vegetation, where alligators hide.

The slight declivity of the Amazon, extending almost to the Pongo de Manseriche, less than 1 foot to every 10 miles, permits the effect of the sea to be felt for about 500 miles from the mouth with reference to the ebb tide, and for a third of this distance for the flood tide. The antagonistic movements of the tide and the river current produce, in the estuary and in the tributaries of the left bank, the phenomenon known as *pororóca*,[2]

[1] "River-ocean" is a term used to express the enormity of the Amazon River.—W.A.A.

[2] The *pororóca* is a huge wave, several feet high, which appears suddenly and with a great noise to break against the river banks.—W.A.A.

so greatly feared by smaller craft navigating that part of the river.

A careful study still remains to be made of the water flow in the entire basin of the Amazon. Generally December to May is the period of high water and April to November of low water, coinciding with the rainy and dry seasons, respectively.

Aside from this variation of the water level there has been observed, in various tributaries far from the mouth, a series of irregular movements with as yet little understood causes. Occasionally some streams empty when they should fill, and vice versa. Furthermore, these movements are not simultaneous for the entire course of the river, there being sections where an accentuated water rise contrasts with a distinct lowering in other parts of the same river, either upstream or downstream. Copious rainfalls in the headwaters, which augment the volume of water and then cause the sudden rise in level, might explain in part these phenomena.

Constant shifting of the main courses of certain rivers, together with the continuous changing of the banks of mud or sand, gives an idea of the complications existing in this intricate river system.

Geographically the division of all this vast extension into similar or uniform zones is not possible, and so there has been adopted the more obvious entity—the river itself. Thus the name of a particular water course is generalized to indicate a certain region; accordingly the names Juruá, Madeira, Xingú, Tapajós, etc., indicate the zones bordering those particular bodies of water. This arbitrary delimitation, imposed by the circumstances, however, applies only to length and not to the depth of land, the latter having but small importance at present considering how little penetration there has been into the forest from the river banks.

In order to specify better the region of a certain locality, a still finer, though inexact, subdivision in terms refers to an area in relation to a certain part of the river, i.e., "upriver," "downriver," "midriver," and the "mouth."[3]

Only in the mouth of the Amazon River do lands take on a special denomination, not following the system just described. Thus we have the name "Region of Amapá" for the area along the left bank, between the Araguarí and the Oyapock Rivers. The term "Islands" applies to all islands existing in the mouth with the exception of the "Marajó," which is considered as a separate entity. Finally, the "Bragantine Region" applies to the right bank of the Pará River, which, according to different geographers, may be either the right branch of the Amazon as a drainage to the sea, or an independent river formed by the Tocantins.

Physiographically almost 90 percent of the total area of the terra firma of the Amazon region is in forests, the remainder being savannas.[4] These are encountered in various places, isolated and usually enclosed by the forest, forming islands in the sea of luxuriant jungle. The most extensive of these islands are found in the Middle Amazon, about 125 miles from the town of Obidos and in the region of Amapá. The Island of Marajó and the Upper Rio Branco contain still others.

Landholdings in the Amazon are exceedingly easy to obtain for anyone interested, private properties often being larger in area than some nations. Leasing is the common mode of exploiting the soil, though this contributes nothing to local progress. No conditions are imposed on the renters or owners, such as compelling them to plant annually a definite number of trees to improve the land. The system favored instead could be called the rape of Nature, because up to the present there has been nothing but the most excessive exploitation, without the slightest regard for conservation of natural resources. This aspect of the Valley has remained unchanged for long years owing to the negligence and shortsightedness of the administrators of public affairs, many of whom are interested in maintaining the *status quo*. What could have been done toward the improvement of the Amazon economy, little by little, during the past decades, is now a load on the shoulders of the new generation, which, as always, has to pay for the errors committed in the past through cupidity, greed, or laziness on the part of a few. The new genera-

[3] For example: Middle Tapajós, Upper Tapajós, or Lower Tapajós.—W.A.A.

[4] Savannas are open areas, characterized by grasses and shrubby plants.—W.A.A.

tion will need to struggle mightily if it wants to conquer this enormous portion of national soil.

Flora.—Paradise of botanists and entomologists, there is perhaps no region in the world to compare with the Amazon in the richness of species, many still awaiting scientific description. Indeed no other country possesses such a large number of indigenous plants as susceptible of economic exploitation. Unfortunately one does not find there great stands of a single botanical species or variety as is the case in other parts of the world. There are regions where one can walk for miles without encountering the same tree species twice.

The native plants of the Amazon having immediate economic value can be grouped according to the type of product as follows: (1) elastic gums; (2) oils and waxes; (3) resins; (4) lumber; (5) fibers; (6) perfumes and essences; (7) special substances.

To the first group belong the following plants:

Seringueira, *Hevea brasiliensis.*
Balata, *Manilkara bidentata.*
Caucho, *Castilla ulei.*
Coquirana, gutta, *Ecclinusa balata.*
Massaranduba, *Manilkara huberi.*

In all these the product is obtained by extraction of the latex, which is later coagulated by various processes. The first three species are of the greater importance, while the last two are harvested only if easily accessible because the low quality of their product hardly ever supports any great cost of transportation.

The region of production serves as an important means of classifying the types of Hevea rubber; thus the standard is considered to be that coming from the higher rivers, particularly the Juruá and the Purús, of the Acre Territory. In addition there is further classification of rubber according to the quality, which is the result of the coagulation and smoking. The categories "fine," "medium," and "sernambí" are used. "Fine" applies only to rubber obtained from perfect coagulation and smoking. "Medium" is badly coagulated rubber, recognized by the milky appearance of the product. "Sernambí" consists of residues, naturally coagulated, unsmoked, and usually mixed with earth and other debris.

The process, used for long years in the extraction and coagulation of the latex to produce rubber, is so well known as scarcely to warrant description here. The method is preserved unaltered; and despite the enormous advantages of the system used in the Orient, no one here is as yet concerned with experiments to produce a better and more profitable product.[5]

In the second division (oils and waxes) the variety of plants is considerable. Of those important enough to figure in commercial statistics the following might be cited:

Andiroba, *Carapa guianensis.*
Babassú, *Orbignia barbosiana.*
Bacaba, *Oenocarpus distichus.*
Copaíba, *Copaifera reticulata.*
Curuá, *Orbignia spectabilis.*
Inajá, *Maximiliana regia.*
Jabotí, *Erisma calcaratum.*
Jupatí, *Raphia taedigera.*
Marajá, *Parenoglyphis maraja.*
Mirití, *Mauritia flexuosa.*
Mucajá, *Acrocromia sclerocarpa.*
Murúmurú, *Astrocaryum murumuru.*
Patauá, *Jessenia bataua.*
Piquiá, *Caryocar villosum.*
Pracaxí, *Pentaclethra macroloba.*
Puxurí, *Nectandra puchiri.*[6]
Tucumã, *Astrocaryum tucuma.*
Ucuúba, *Virola surinamensis.*
Umarí, *Poraqueiba paraensis.*
Umirí, *Humiria floribunda.*
Urucurí, *Scheelea martiana.*

Many of these plants are palms, and from all, with the exception of "copaíba" in which the trunk is utilized, the oil is extracted from the fruits. This oil is used for various purposes, one being the prime material in soap and another a culinary substitute for olive oil.

The method of collecting is, in the majority of cases, the most curious imaginable. The palm fruits are fished, so to speak, out of small creeks on the islands where the plants grow. The fruits are carried along by the ebb-tide current, and the nut gatherers station themselves in canoes at strategic points

[5] This statement is no longer true in view of the important research at the Instituto Agronômico do Norte, in Belém, toward the development of perfect smoked sheets and their introduction into the Amazon production.—W.A.A.

[6] See translator's note, p. 33.

to sweep up the harvest by means of a special kind of basket.

In the resin group are: "jutaícica," *Hymenaea courbaril;* and "breu da terra," *Protium heptaphyllum.* Despite the few species figuring in the market the first named is of considerable value in the paint industry.

To describe all the trees furnishing lumber would be the task of a specialist and would fill several volumes. The more notable are:

Acapu, *Vouacapoua americana.*
Coaruba, *Vochysia vismiaefolia.*
Cupiúba, *Goupia glabra.*
Freijó, *Cordia goeldiana.*
Louro preto, *Nectandra mollis.*
Louro vermelho, *Ocotea rubra.*
Macacaúba, *Platymiscium duckei.*
Marupá, *Simaruba amara.*
Massaranduba, *Minilkara huberi.*
Pau amarelo, *Euxylophora paraensis.*
Pau santo, *Zollernia paraensis.*
Piquiá, *Caryocar villosum.*

The hardwoods of this region are characterized by a high specific gravity but for the reason already explained the filling of orders for specified amounts of any one species is very difficult.

Among the fiber plants, diligent studies have encountered types to fulfill any requirement, but only the following three native ones are sufficiently developed to supply a market which is in itself not very important:

Uacima, *Urena lobata.*
Piassava, *Leopoldinia piassaba.*
Sumaúma, *Ceiba pentandra.*

It may be noted that the "sumaúma" could be called the queen of the forest because of its gigantic size. Its product resembles the "kapok" of Malaya.

In the group of essences and perfumes there are:

Baunilha, *Vanilla fragrans.*
Cumarú, *Dipterix odorata.*
Pau rosa, *Aniba rosaeodora.*

The first is well known for the value of its perfumed pods and is the only orchid utilized for its fruits. The production is insignificant. From the "cumarú," or tonka bean, an essential oil is extracted which is used in medicine. From the wood of the "pau rosa" rosewood oil is distilled. It contains an active principle "linalol" and is used as a fixative for perfume.

In the miscellaneous group are:

"Jarina,"[7] *Phytelephas macrocarpa*, a small palm producing seeds which are called "vegetable marble." They are used to make buttons and small carved objects.

"Guaraná," *Paullinia cupana*, the fruits of which yield a substance with tonic properties, used in the preparation of a soft drink. This drink, also called "guaraná," consisting mostly of colored water, sugar, and carbonic acid, is popular in Brazil. It is sold, to some extent, abroad.

Brazil nuts, *Bertholletia excelsa*, which are well known and have great food value due to the high protein content. For this reason the name "vegetable meat" could be applied rightly to the food.

"Timbó," *Lonchocarpus utilis* and *L. urucu*, can also be included here. The plants are woody climbers, whose roots contain a poison highly toxic to cold-blooded animals but not to those of warm blood. The active principle is known as rotenone and all the advantages of a perfect insecticide are attributed to it.

All these plants, without doubt, are natural resources, but they are so widely dispersed that anyone interested in securing a certain product cannot be told where it may be found in the quantities desired. Furthermore, normal methods of harvest, as ordinarily conceived, would not avail.

In the entire Amazon Valley the flora is so intermixed that if a square kilometer (0.38 sq. mi.) of ground could be marked off only a single specimen of any one of the different kinds of trees probably might be found therein. Nevertheless, zones do exist where a single or sometimes a group of species occur in denser stands. For example, the oil palms are numerous in the region of the Islands; Brazil nut in the Middle and Upper Tocantins River; and "jarina" in the Middle Solimões. A further exception must be made for "guaraná," which is found only in the municipality of Maués and vicinity, in the State of Amazonas. For all the others dispersion is the rule; highly interesting from the botanical standpoint but very disillusioning for all other purposes.

When the time comes to initiate intensive cultivation of the various native plants of the Amazon, which in itself will be a vast

[7] See translator's note, p. 33.

program, there will have to be some means of selecting the more suitable locations. The frequency of occurrence of the plant itself will be one of the easier methods to guide the future students in the choice of the best sites. However, the principal criterion in the selection of these future sites should be easy accessibility. The harvest of a native product costs practically nothing to the worker, aside from his own maintenance. It is the transportation, not only of the things he needs but also of those he produces, which is the major factor in the cost of the article. It is obvious then that regions must be chosen which permit efficient and rapid connection with the centers of consumption and distribution, if there is to be proper economic development.

Fauna. The Amazon fauna is as varied as the flora. In addition to numerous noxious insects and reptiles, which are dreaded by the inhabitants scattered through the Valley, many animals of economic value are to be found.

So far there has been no attempt to create wildlife preserves for industrial purposes. Instead there has been a merciless and indiscriminate slaughter, which leads to the danger of exterminating certain species. It is practically impossible to enforce hunting laws in the vast hinterland where the hunters practice their profession.

The active commerce in skins, encountered in nearly all the Amazon region, is based on numerous kinds of wild animals:

The "veado vermelho" (red brocket), *Mazama americana,* is one of the animals which contribute most to the exportation. However, the most valuable is the "ariranha," *Pteronura brasiliensis,* a large otter now little seen because of the intensity with which it has been hunted. In addition to these the "caetetú" (collared peccary), *Pecari tajacu* and the "queixada" (white-lipped peccary), *Tayassu pecari;* capybara, *Hydrochoerus hydrochaeris;* "gato maracajá," *Felis wiedii;* "maracajá-assú," *Felis pardalis;* and "onça pintada," *Felis onca,* form a part of the valuable and specialized commerce with the United States. The most important reptiles are the "jacaré" (alligator), *Paleosuchus palpebrosus, Caiman niger,* and *C. scleropa,* especially since their hides have been introduced into industry in the form of shoes. The lizards, "jucuruxí," *Dracaena guianensis,* and "jacurarú," *Tupinambis* spp., as well as the "camaleão" (chameleon), *Polychrus* spp., are also employed in this manner but to a lesser degree. Certain of the snakes, such as the "giboia," *Constrictor constrictor,* furnish their quota but now less on account of the change in fashion.

Food fishes of an enormous variety exist in the rivers and lakes. The most important is the "pirarucú," *Arapaima gigas,* very abundant in the Lower Amazon where it is caught principally during the period of July to November, the season of low water, when shoals of the fish swarm into the marginal lakes for spawning. Despite its prodigious fecundity, this largest member of the order may soon become extinct if the fishing continues at the present rate and during the least propitious time.

One of the most typical scenes of Amazon life is fishing for "pirarucú" with harpoons. A special dexterity learned from the primitive Indians, as well as a keen vision, is needed. Some specimens weigh nearly 175 pounds and measure more than 6 feet in length. They are usually salted and dried in the sun before being eaten. This curing, even yet, is done under the most primitive conditions possible. Consequently the product is not the sort to satisfy a fastidious palate, and the markets of the south are unwilling to accept it as a substitute for foreign codfish.

Apparently conditions in the fishing colonies are unsatisfactory. These groups were created after the nationalization of the industry; but nevertheless production has greatly diminished in some places and disappeared entirely in others. Water being the major element and fish so plentiful, the unimportance of the fishing industry is incredible.

Another inhabitant of the rivers, a local curiosity, is the "peixeboi" (water-cow), *Frichechus inunguis,* an aquatic mammal of considerable size. The flesh is appreciated by some and is sold fried in its own grease under the name of "mixira."

Turtles abound in great variety, the best

known being the great turtle of the Amazon, *Podocnemis expansa.* It is one of the traditional native foods. Others, lesser known, such as the "tracajá," *Podocnemis dumeriliana,* and the "mussuan," *Kinosternon scorpicides,* are greatly sought to supply the demands of gourmets.

Only a few birds have value other than purely ornamental. The delicate feathers of the "garça" (egret), *Egretta thula,* once created a large and lucrative business but only the demands of feminine fashion will determine whether the egret will again be commercially profitable. The "mutum," *Crax alector* and *C. globulosa,* large gallinaceous birds, with flesh as delicious as that of a turkey, could be an important food item if bred on a commercial scale.

A clam, fairly abundant in the Tocantins River, furnishes a shell of considerable importance in the mother-of-pearl trade. The pearls found occasionally in these shells are considered merely a curiosity.

Just as the now highly prized alligator has been considered useless, or even noxious, likewise other animals might eventually prove to have commercial value.

Formerly all these animals were easily found along the banks of the more accessible rivers, but they are becoming scarcer as they retire to the deeper recesses of the forest to escape indiscriminate slaughter by hunters who, through necessity or ignorance, give little heed to the laws for the control of such activities. A complete extermination of some valuable species can be expected in the near future unless conditions change.

The majority of skins sold in local markets comes from animals originally killed for food, in places having no other source of meat. Thus the skins figure primarily as supplementary articles of commerce. The lack of more efficient and forceful methods for the restriction of shipments and confiscation of skins of protected animals leaves much to be desired. For this reason it is urgent that the provisions not be confined to prohibiting hunting, if some of the species are to be saved.[8]

Breeding farms, similar to those elsewhere, to raise animals whose hides have commercial value should be promoted. These farms will be of economic advantage in conserving the species and in preventing losses due to poor skinning and curing. Also the meat might contribute to the local food supply.

An economic survey of the opulent Amazon fauna would be a notable work from every point of view, particularly benefiting industry and trade.

Climate. Although the Equator divides the country into two unequal parts, with the smaller lying to the north, the temperature does not have so great an influence on human life as many suppose. In fact, the mean temperature is less than that found in the same latitude in other parts of the world. A temperature curve based on observations over a long period of time indicates that the temperature rarely rises above 93° F. in the shade and that normally the thermometer fluctuates between 68° to 90° F. under the same conditions.

The atmospheric humidity, however, is of great importance, especially during the rainy period, improperly called the "winter season," which extends from December to May, being most extreme in February and March. During this time the degree of saturation is regularly above 90 percent, and even in the driest periods it is seldom less than 70 percent, the absolute minimum observed up to the present being 43 percent.

In a region cooled by the antitrade wind and winter rains, one cannot complain very much of tropical heat except during short intervening periods. The origin of various absurd generalizations about Amazon weather can probably be traced to travelers who stopped overnight in Belém on the air route between the two Americas. Although having spent only a few hours between planes in a city at the extreme end of the Amazon Valley, some of these travelers have been overheard later to classify the weather by such contradictory terms as "very hot," "very dry," "chilly," or "rainy." Impressions such as these, created by exceptional weather conditions, come to be regarded as accurate and finally appear in an article or book with all the seriousness of a profound treatise on climate. It is interesting to note how soon people staying for a while give up such preconceived ideas.

[8] See translator's note, p. 33.

Aside from the rain there is no important meteorological condition which could influence the general economy. The barometric pressure is almost constant throughout the year, and conforming to the altitude the mean readings are between 994.9 to 1,009.5 millibars (29.5 to 29.8 inches).

The scarcity or abundance of rain in a certain year, as well as the premature or delayed beginning or end of a season, seems to have great influence on the volume of commercial shipments. Apparently the only plausible explanation is the irregularity of the summer season preceding the harvesting time. This can be verified by the fact that one year of high production is often followed by another in which the volume is reduced to 20 to 40 percent.

An interesting climatic phenomenon, occurring suddenly and irregularly in the Upper and Middle Amazon, is known commonly to the people as a "friagem" (chill). It consists in a sudden lowering of the temperature, usually at night. The thermometer may fall below 50° F. for a few hours, causing shivering and chattering of teeth among the inhabitants. One explanation is that masses of cold air descend from the Andes, owing to the lowered pressure in the locality concerned. The sudden and rare hail storms reported in some places might be explained in like manner.

Data are insufficient for an accurate climatological study of the Amazon Valley, because of the comparatively few weather stations in relation to the immensity of the territory. The present service certainly will be widened to keep pace with the expansion of airways, so that there can be more complete data to explain the effect of weather on the flora and fauna.

The new science of dendrochronology (the study of weather by means of the growth rings in trees) would aid in obtaining valuable data for a climatological map of the past. Graphs made from such studies would reveal what had occurred in various zones, even where no meteorological observations have been made as yet. In the same way future variations of the weather might be forecast.

A chain of weather recording stations should be situated at strategic points to secure daily information on rainfall. To coordinate such data with records of water flow in the rivers would do much to explain the sudden, but still unexplained floods noted in some rivers. Data of this kind would be highly useful to Amazon navigation.

The climate will be no serious obstacle to the development of the Amazon, once this region is integrated with the rest of the Brazilian community on the road to a glorious future.

People. The origin of the extinct race, once inhabiting the mouth of the Amazon and a few of the tributaries, is still wrapped in deepest mystery, the only remains being the ceramics of Marajó and Santarém.

Scattered tribes of Indians in the headwaters of the higher rivers are now mostly influenced by Christianity, although a few continue to repel any approach whatever. The remnants of the tribes who used to live in the Lower Amazon are now integrated with the general social structure, and intermarriage is contributing to the dissolution and disappearance of the primitive types. It is curious to note the strongly Mongolian appearance of some of the descendants of these original inhabitants.

The Amazon being the part of the country least touched by a large-scale immigration, no great nuclei of foreigners are to be found. The Syrian and Portuguese elements, which have contributed so greatly to the commercial development of the country, are encountered only in the state capitals and larger towns, but even they are being rapidly assimilated.

The immigration trend of several years ago brought Japanese colonies to the municipality of Parintins, in the State of Amazonas, but fortunately these were broken up in time. Similar settlements in the State of Pará, in the municipalities of Monte Alegre and Acará, were somehow unsuccessful. For this reason the "yellow peril" of the Amazon is not so important as might be suspected, when we consider the publicity which has been given to the subject.

The bulk of the colonization in the Amazon was made by the northeastern Brazilians. Plagued by the rigors of droughts in their own land and attracted by the fascinating

possibilities of rubber, these people have braved the jungle and have done much to improve the country where they have made their new homes.

As opposed to the conditions in south and central Brazil where slaves were the main support for the great crops of sugar and coffee, there has never been any influence of servile labor here. Consequently very few Negroes were disseminated in the Valley to dispute the dominance of the "caboclo," descendant of the primitive Indian.

Freedom from worry about food or inclemency of the weather has created in the native a most simple view of life. Without ambitions, and with few immediate wants, he limits himself merely to enough work for maintenance from day to day, certain that existing conditions will remain continuous and uniform. This mode of life, however respectable from a philosophical point of view, is not one which favors progress, but it may after all be an intelligent way of living, free from the uncertainties of the so-called supercivilized people who are obliged periodically to blow each other to bits.

The exploitation of the native is the chief trouble resulting from his apathy. Because of the impossibility of enforcing laws to protect workers dispersed over such an immense territory, they are often subjected to a regime of work very close to slavery. Thus, only the few have enjoyed the rewards secured in this objectionable manner. They lived in the larger cities in sumptuous homes or made frequent trips to foreign countries to spend prodigally their ill-gotten wealth. Their profits were secured by double exploitation, in the worst sense, of both Nature and man. This caste of "colonels"[9] of the interior, who administered justice and who were the main prop of the corrupt and extinct regime of Brazil in 1930, fortunately has now almost disappeared. A few, however, with cunning ability still manage to survive.

Man, the major factor in any question, complicates the subject mostly by his absence from this part of the country. Actually, with a population density of much less than 1.5 per square mile, it will be difficult not only to find means within Brazil to solve this need but also to secure a foreign source of adaptable immigration which will not cause trouble in the future.

All this train of interlaced situations, designated *The Problem of the Amazon,* has been created by the improvidence of the people themselves. In seeking the riches yielded by Nature they have not penetrated more than a few miles into the forest and thus have brought about the multitude of tiny and widely dispersed villages along the banks of the rivers. However, full admiration must be rendered to the courage and pertinacity of those who have been confronting all obstacles to maintain themselves in localities where in reality civilization has not yet touched. They are Brazilians worthy of the name, and they represent the national sovereignty over this immense and coveted territory.

Because of the isolation from the rest of the country, the Amazon region still conserves habits and customs inherited from the primitive inhabitants. The folklore is rich and serves to show the dominance of Nature over man, which is exercised in an almost absolute manner. The introduction of modern, progressive ideas is retarded somewhat by numerous superstitions and taboos, but these can be overcome by the adoption of intelligent and persuasive methods of teaching, owing to the docile and comprehending spirit of the people.

Although small of stature the native of the region is generally rather robust, except of course, those born in the larger towns, who are conditioned to other ways of living. Sobriety and simplicity of diet, as well as close contact with Nature, are some of the factors explaining his good physique. From this can be foreseen what the individual of the Amazon will be once he is educated, properly fed, and freed from the endemic diseases which plague him. The human element of the region should not be underrated or looked upon with pessimism, because in comparison with peoples in the same latitude of other countries there is none who presents better or even equal characteristics, especially when the conditions of the Amazon are taken into consideration. Instead of

[9] The term "colonel" is applied to the river lords of the Amazon who made immense fortunes during the rubber boom of the past.—W.A.A.

criticism, no matter how constructive, it would be better at present to have some sort of decisive action to remedy the situation.

The paralysis of progress in the Amazon has greatly limited the opportunities for any individual with a desire to improve his station in life. It has obliged and is still obliging him to migrate to the south in search of a better and more stable future. Annually great numbers of people drift to the capital of the Republic, attracted by the fascinations of the "Marvelous City," and end by filling the already overflowing pavements of the avenues. Even those called away for military service finally prefer not to return to the Amazon with its ever-diminishing population. The fact that this exodus consists of males can explain the smaller marriage rate and the considerable reduction in inhabitants as revealed by the last census.

Although there are many who extol a march to the west, there are few who practice it, and so the only means of securing personnel for the works contemplated for the Amazon will be to utilize to the best advantage the scanty resources of the existing manpower.[10]

Whatever may be the effort asked of man in the Amazon for the realization of that which he most desires, consciously or not, it is certain that he will respond with the greatest willingness, even to sacrifice, once he is convinced of the elevated intentions and the sincerity of those who are to be charged with the resurrection of the great territory where he was born.

Culture. The status of popular education in relation to the national panorama is well known, and although it is true that the degree of illiteracy diminishes year by year yet the percentage still remaining is serious. The Amazon, being an integral part of the Nation, cannot be considered as different in this respect, especially when specific difficulties are taken into consideration. The state capitals and large towns have done much to advance education. The statistics of matriculation and attendance at public schools, as well as the laws for public education which are being formulated by the various states, are proof of the forces being made to improve the cultural aspect of the local populace. Considering the widely dispersed settlements and the meagre funds available to the municipal administrations, we can readily understand the difficulties of raising the educational level of the Amazon people.

The shortage of teachers to fill positions in the interior is one of the difficulties confronting the officials in this branch of public administration. There is no scarcity of capable personnel, which, on the contrary, exists in an appreciable degree among the yearly graduates from the normal schools. What actually happens is their refusal to accept positions in interior towns. Although this reveals an inadequate spirit of sacrifice for the good of the country, yet it is understandable when the refusal is made by a young woman who would have little or no opportunity for marriage were she assigned to some remote place. She would have no civilized comforts and often would be financially unable to bring along members of her family.

This presents a general picture in so far as primary education is concerned. Technical or professional preparation does not exist in the interior and is very limited even in the State capitals, owing to the few institutions qualified to give instruction of this kind. Another contributing factor is that the great majority of young people are unable to attend such schools because they have had to begin working after completing the secondary schools to help support their families.

Apprenticeship to the professions is made by a long-continued service, during which are acquired all the faults and defects of the trade. For this reason there is no good handicraft, and the workmanship of labor is of the lowest quality. The absence of large industries is one cause of this situation, and furthermore the industries have not developed for lack of skilled workers, thus forming a vicious circle not easy to change by ordinary methods.

Higher education lacks neither schools nor students, but there is a great paucity of positions where the graduates may later practice their professions. Every year a new group

[10] Recent activities to bring in new labor from northeastern states have not been as successful as hoped, but a solution of the problem is still being sought.—W.A.A.

of doctors and bachelors of arts appear who are forced to seek government positions once they discover their limited opportunities in other fields. The same is true of the school teachers, all of them preferring to live in the state capitals where there is already a superabundance of colleges with permanent staffs, so that success is a matter of luck or persistence.

An exception to the rule is found in the engineering school, because its graduates find immediate employment despite the somewhat theoretical teaching received. Aside from this exception it is true that there is a shortage of technically trained people to bring advancement to the country. Even so, if all the students continue to pursue the same specialty—civil engineering—then in a short while saturation will leave them in the same predicament as their colleagues, the doctors and lawyers.

There are courses in agronomy[11] and veterinary, but unfortunately the graduates from these have no opportunities to practice their profession independently. Rare is the landowner who seeks the services of a specialist for advice on crops or cattle improvement. These graduates are forced to seek refuge in public service if they wish to follow their specialty. Since even this opening is limited, discouragement results with consequent abandoning of the career.

In chemistry, where the possibilities are infinite and employment certain for those who actually know the subject, not a single course is being offered at the present time, despite the brilliant record of the past in Belém. The School of Industrial Chemistry, sponsored by the Commercial Association and directed by that great Amazonist Paul Le-Cointe, unfortunately is now closed after having turned out a handful of competent professionals, thus cutting short a fine and useful work for the region. All attempts to reopen the course have been frustrated by bureaucratic complications of the educational boards, which, being situated in the Federal Capital, are absolutely uninformed on the actual conditions of the Amazon. No one who really knows the Amazon could admit the possibility of applying here certain of the laws and regulations which were formulated for the entire Nation.

The dearth of technically trained men to serve in the obligatory orientation of producers leaves the latter free to continue the primitive methods of exploiting the soil. Such trained men can be obtained only from schools specializing in practical instruction without emphasis on general cultural subjects. The granting of degrees should be postponed to some future time in those institutions concerned with the professional preparation of the individual. The main thought, therefore, should be to prepare the student genuinely to fulfill the role for which he is intended.[12]

People who can fill technical positions in the interior will not be recruited in the larger towns; instead it will be necessary to utilize young people of the same locality where the future work is to be carried on. Only this will assure a useful corps of collaborators.

It is necessary to point out, excluding of course the already too well-known unscrupulous politicians and opportunists, that a highly developed national sentiment is to be found in the Amazon, even among the most untutored. It is not always easily recognized but becomes evident in appropriate occasions.

Civic spirit has been manifested throughout our history by such heroic episodes as Placido de Castro, in the Territory of Acre, and Veiga Cabral in Amapá, when the threat to national sovereignty was met with prompt defense without need of stimulation or promise of reward. Much can be expected still of these anonymous makers of the Nation, everything depending upon the method by which they shall be trained, and upon the confidence engendered by those who are to guide their destinies. At present this confidence is at low ebb in reaction to past oppressions.

11 Not now true because the small school of agriculture in Belém has been closed for some time.—W.A.A.

12 The inference is that the present system produces graduates who consider themselves to be "white-collar" workers qualified only for executive or office duties. It would be beneath their dignity to soil their clothes or to engage in arduous manual demonstrations.—W.A.A.

(To be Concluded)

MAPPING SOME EFFECTS OF SCIENCE ON HUMAN RELATIONS[1]

By S. W. BOGGS

CHIEF, DIVISION OF GEOGRAPHY AND CARTOGRAPHY, DEPARTMENT OF STATE

THE earth has changed but little since Man appeared, but the geography of human relationships has been transformed in a few decades. Because science knows no frontiers, scientists perhaps tend to overlook the remarkably uneven geographic distribution of the effects of their work.

The popular picture of a rapidly shrinking globe, based on the reduction of time required in circumnavigating the earth, is inaccurate and unfortunate. The world has not shrunk as if two thousand million microscopic ants had been banished from a pumpkin to live on a cherry. For the individual and for all types of corporate society the range of activity and experience and the resources at the command of the individual and society have expanded astronomically. But the effects are distributed very unequally over the earth's surface; the geographic distribution is shifting rapidly and will apparently continue to undergo great changes. The present picture therefore gives no adequate concept of what the future may be like. It is as if the outlines of continents were picture frames within which appeared ever-changing motion pictures, like montage effects in the cinema news reels.

Little has been done by geographers and others to map these phenomena. Any maps that might be devised to portray them would be as definitely dated as the constantly changing political maps of the world. A chronological series of such maps, however, would constitute a slow-motion study, and perhaps would reveal or clarify important historical trends. Intelligent men instead of struggling vainly against the tide of history—now more like a cataclysmic tidal wave—might adapt themselves to making use of its power.

It would not be necessary to go back much farther than the year 1790 or 1800 for perspective. Tool steel and machine tools, which date from about 1770, began to make possible the utilization of scientific discoveries. The period is likewise significant because of the birth in the Americas of an infant republic and the spread in Europe of the ideas of the French Revolution, while in China that period coincides with about the maximum extent of the Manchu empire.

Maps are advantageous for the presentation of data of this character because they can show graphically the location and the extent of change, and cannot evade areas and subject matter as dexterously as text can. Maps, however, require accompanying text to reveal significant points which might otherwise be noted by very few map-users. For most of these maps colors and atlas-quality reproduction on fine paper, like those for the best physical and political maps, are required. The accompanying cartograms in black and white merely suggest a few of the possibilities discussed below.

In 1700 the distribution of available energy was practically uniform over the land surface of the globe, since man depended chiefly upon his own muscles, slaves, and domestic animals. But the multiplication of physical energy utilized by mankind, which is basic to all technological development, has resulted in an extremely uneven distribution of power utilized today. A lump of coal weighing about one pound now performs as much physical work as a hard-working man in an eight-hour day; and one miner can mine several tons of coal a day. The present diversity in levels of living is due largely to differences in the quantities of energy use per capita by various peoples for productive purposes. The map (Figure 1) reflects the situation in 1937. The changes within the last quarter century have been great, and they may be as great or even greater in the next twenty-five years.

[1] Paper read before the American Association for the Advancement of Science, Section L (History and Philosophy of Science) at Cleveland, Ohio, September 13, 1944.

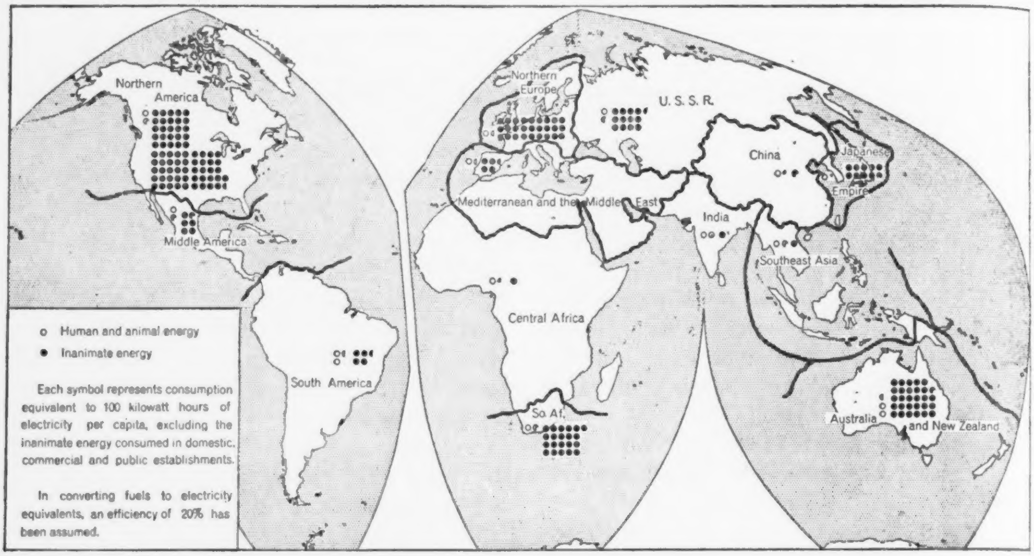

FIG. 1. ENERGY CONSUMED PER CAPITA FOR PRODUCTIVE PURPOSES IN 1937

Technological changes resulting in economical mass production and revolutionary developments in transportation and communication have produced two significant and closely related results: (1) Man's relation to his local environment has been radically altered; and (2) human relationships have been transformed on a global scale. Men can go farther, bring more back home, utilize more raw materials, and do much more with what they get than even the scientifically-minded and far-seeing Benjamin Franklin and Thomas Jefferson could imagine.

Available transportation maps usually show only the principal facilities, with little attempt to present significant differences in cost per ton-mile of freight movement. On a map centered at St. Louis, Missouri (Figure 2), as of the year 1804, equal-rate distances by different means of transport present a very simple pattern, with long fingers following the rivers, six or seven times longer downstream than upstream, and extremely slender because of the high cost of land transport in terms of human and animal effort.

The relative efficiency of land and sea transport prior to 1800 is illustrated by the fact that coal had been mined in Wales since Elizabethan times only where the sea actually cut into the coalfield. Cardiff, only six miles from the nearest coalfields by land, imported coal from Tenby and other ports to the west. An official customs report in 1775 stated that no coal was exported from Cardiff, "nor ever can be, its distance from the water rendering it too expensive for any such sale." Such are the hazards of prophecy in a world of changing technology. Indeed, as a supplement to navigable rivers, canals provided the only cheap inland transport, when they could be dug by the simple means then available.

On the map centered on St. Louis today the contrast in the cost of freight traffic with that of about 1800 reveals great expansion in all directions, notably where railroads and motor roads rival the lower-rate river transport; present river rates, however, are based on a certain percentage of railroad rates,[2] so that the down-river distance for a given price is now less than it was nearly a century and a half ago.

Figure 3 is a cartogram intended to give

[2] The fact that a ton of freight may be moved one mile by railroad, as in the United States, for about 1¢, or the wage of an unskilled laborer for one minute, is the significant fact in land transport. The rail tariff on wheat, Omaha to Buffalo (1,001 miles), is 8.9 mills per ton-mile; on the Great Lakes, Duluth to Buffalo (986 miles) the rate is 2.0 mills per ton-mile, which covers a toll-charge through the Locks.

a visual impression of the comparative efficiency of the principal means of transport. A steamship will usually carry a ton of freight eight or ten times as far as a railroad, for a given sum of money, and from one hundred to several thousand times as far as human porters or pack animals. The bars in the diagram indicate in a general way how far a ton of bulk freight, such as wheat, can be transported for a sum approximately equal to the daily wage of a human porter in regions which lack railroads and motor roads. The maps in different scales are so proportioned in size, very roughly to be sure, that equal distances on all maps represent equal cost in terms of human effort. The map scales are therefore the reciprocals of the mean value of the bars in the diagram.

This cartogram in black and white is incidental to the preparation of a world map in color, not yet published, which constitutes an attempt to show the approximate cost per ton-mile for freight movement in all parts of the world today. Such a map brings out the areas in which surface transport is possible only on men's backs or heads, or on pack animals, or by means of animals pulling carts on rough roads. Here the cost factor of primitive transport is represented graphically in the legend by a very steep slope, and one may imagine porters or pack animals toiling up these symbolic but very real slopes until they become exhausted. People in these regions are walled in by high transport costs. Railroads, with a cost factor per mile like the gradual upward slope of a smooth coastal plain, cut through the areas of high primitive costs like a great river which has incised its channel through a mountain range in past geologic ages.

Such equal-cost-distance maps may be called "isotimal," from the Greek word *isótimos* meaning "equal cost or effort." In

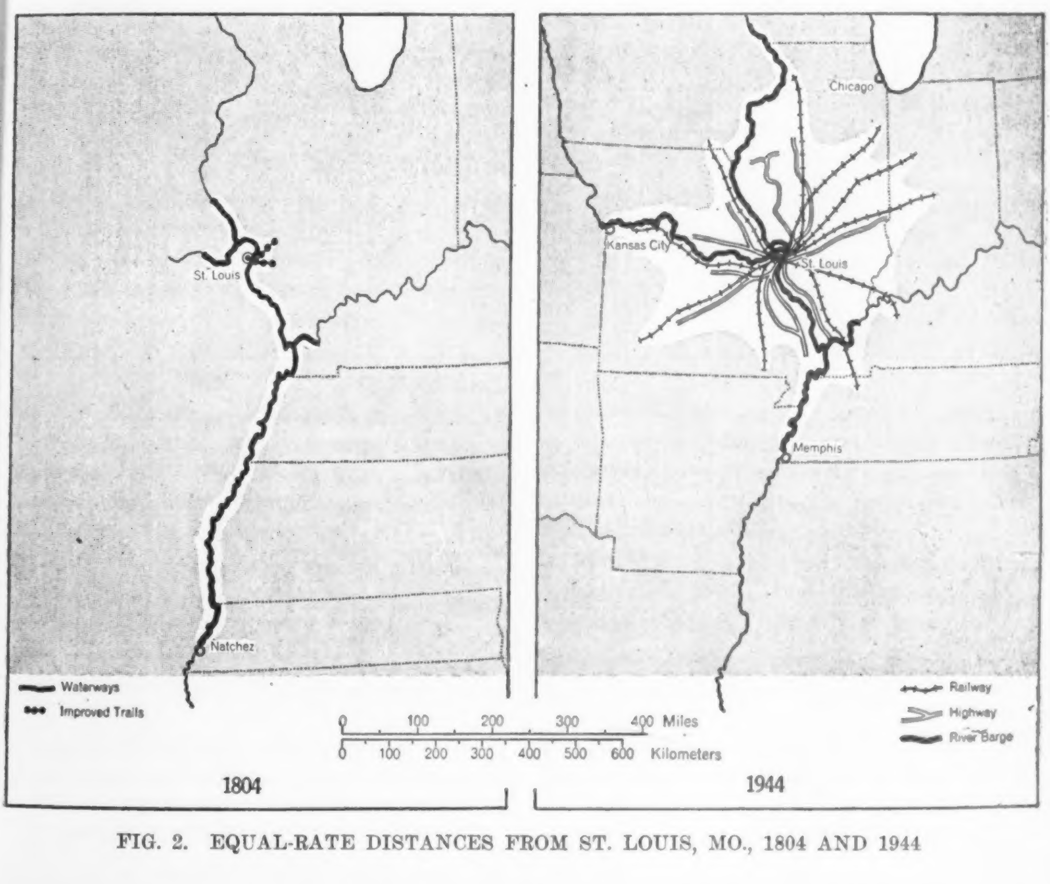

FIG. 2. EQUAL-RATE DISTANCES FROM ST. LOUIS, MO., 1804 AND 1944

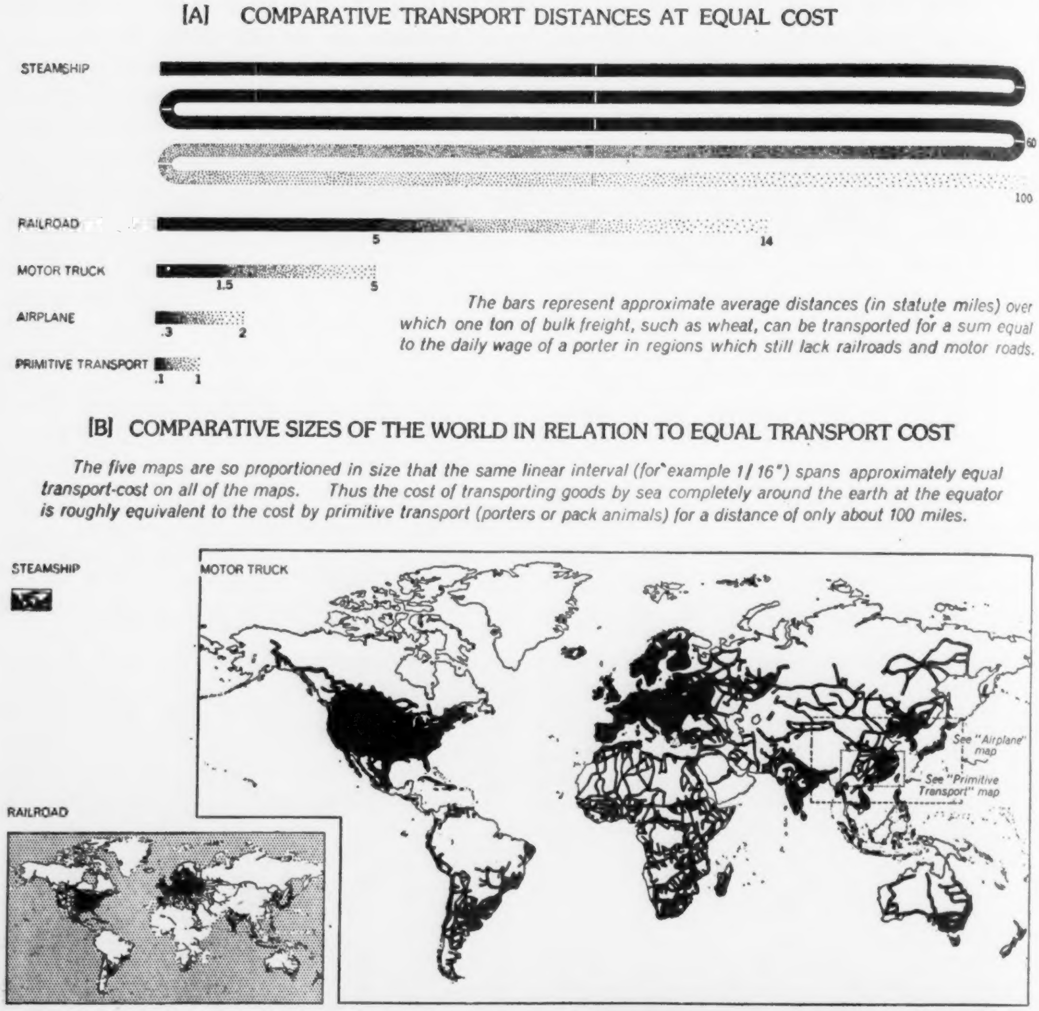

FIG. 3. TRANSPORT BY DIFFERENT MEANS AT EQUAL COST

compiling a map of this type, one would like to get back of the complicated rate structures of railroads, motor truck carriers, river and ocean shipping, and measure cost in units of human effort. The march of physical progress could be recorded largely in a chronological series of such maps.

This access to distance, due to cutting the

cost with mechanized transport, largely accounts for contrasts such as that portrayed by the world maps of wheat production and commerce for 1800 and today. In 1800 the farmer who raised wheat did not dream of selling his product more than a few miles from home, where he could haul it by team and wagon or send it a little farther by river or sea. The human use of the grasslands has been revolutionized by the railroads, the breeding of new wheat strains, the invention of roller milling and other machinery, and the opening of European markets since the industrial revolution. Consequently, wheat grown in four continents today competes in a fifth. Comparison of a map showing both the areas in which wheat was produced and consumed in 1800 with a similar map for today reveals the intimate relations between the railroad net and the areas in which wheat growing has been greatly extended in nature's grasslands.

Maps of many new types may be prepared to depict the geographic distribution of the effects of science and technology upon human relations.[3] Among them might be maps showing the following:

(a) For a given place and several dates, the percentage of goods used in that place or region which came from distances of 10, 100, 1,000, 5,000, or 10,000 miles, thus providing some measure of expanding interrelationships.

(b) For any product for which there is now a world market, the historical geography of production and distribution.

(c) Decreases in cost of production per unit of output, by region and date.

(d) Travel speeds, by regions, for various dates.

(e) Communication costs and volumes of communications, by region and date.

(f) Geography of aviation development—factors conditioning the establishment and operation of air services.

(g) Cultural relationships between different regions.

(h) Levels of living, based on various yardsticks.

(i) Social results of medical science.

(j) The principal bases of prestige in various countries or regions, upon which concepts of success and leadership depend, some of them having been modified in recent decades by the development of certain industries.

One of the principal generalizations of geography is that there is very uneven, one may almost say very lop-sided, distribution of the earth's resources, of land and sea, climatic zones, productive soils, population, and other factors. The influences of these inequalities of geographic distribution are very different from what they were fifteen decades ago—even five decades ago. Some may naïvely imagine that the effects of this uneven distribution have been practically obliterated. On the contrary, they have simply been given new values, and some of them are more significant than ever. Just as the geographical factors have by no means been eliminated in war, in these days of mechanized warfare and of airplanes, so their influence in peace is constantly changing and is as yet inadequately appreciated. In terms of past experience it is as if we were living at the same time on several worlds whose differences in size were of almost astronomic proportions.

However great may be future changes in world maps showing the distribution of population, transportation and communication facilities, exploitation of minerals, and the like, the pattern appears to be already well developed. The abstract pattern of relationship possibilities, moreover, is not likely to change as much as it has already changed within the last century. In at least one direction the ultimate has already been attained. Communication is almost instan-

[3] Maps of the world presenting data very objectively and impartially are most needed. To the people of this or any other country they would afford assistance in understanding the viewpoints of peoples whose historical backgrounds and environments differ greatly. It may be remarked that one of the most notable atlases in recent years is the Great Soviet World Atlas, projected in three volumes, the first of which, published in 1937, was devoted chiefly to world maps of great variety. Presumably an even greater contribution to world understanding could be made if such a map series included more maps specifically designed to show when, where, and how great have been some of the changes in human relationships between regions during the last century or more.

taneous, with the speed of light, and may reach all points of the globe at once; it is being extended through television and the use of many electronic devices.

In the days of both Nebuchadnezzar and Napoleon the fastest travel was at the rate of a fraction of one percent of the velocity of sound, whereas today it rapidly approaches the speed of sound, but presumably can never attain a speed many times that of sound. The efficiency of the railroad might conceivably be doubled or quadrupled, but presumably no method of land transport can be devised which will reduce the cost to a level of that of the most efficient ocean freighter. One factory machine may now perform the labor of 10,000 human beings working by hand, but even if a new machine is invented which will produce as much as one hundred machines do now, the order of change will be less than that which has already occurred. The wizardry of chemistry already unites rare materials from the ends of the earth so that men who produce tungsten in Kiangsi Province, China, are closer as economic neighbors in normal times to Pittsburgh, the Ruhr, and the British Midlands than to communities in China one hundred miles distant.

Scientists will doubtless produce marvels far beyond our present conceptions. Their insatiable curiosity is now penetrating fields of invisible and astonishing forces; they operate without fear and in a spirit of humility before facts which enables them to discard outworn hypotheses and to learn new ways very rapidly. The changes to come in many regions hitherto referred to as "backward" may greatly exceed those already manifest in areas in which changes have been greatest in recent decades. The maps of human activities and relationships will doubtless pass through rapid metamorphoses in the near future.

Flat maps cannot effectively reveal relationships of air travel and transport and of radio. While many types of aviation and telecommunication maps should be made, special globes and accessories are almost essential.

Man has a fondness for circulating which accounts for some of his problems of relationships. Circulation is the rule in nature, of the air itself, of the sea, many birds, and some animals. Man's new facility of movement enables him to circulate with freedom equal to nature in its freest moods.

People everywhere, even in remote places, are thereby being stimulated through contacts by radio, the press, the airplane, the marketplace. Human friction and heat may thus be generated. But to try to build a sort of wall to exclude contact, instead of to become adapted to it, is futile—a crustacean psychosis in an avian age.

The amazing discoveries of scientists and the resourcefulness of engineers and technologists afford assurance that men's needs on the physical level can be met. The most difficult and important problems for the future which have stemmed from scientists' laboratories are the problems of human relationships, which have been multiplied almost beyond conception. Institutions with adequate resources, young men and women whose understanding of the world in the last few years has been broadened and deepened, may, by using geographers' techniques in the cartographic interpretation of spatial relations, provide us with maps that will carry us a long way toward a sound understanding of the world in which we now live.

INSECT RESPONSE TO COLORS

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We know nothing of the sensations that insects experience when they see either colored or white light, and hence it was thought best to entitle the article as above. In this way any intimation that insects have color perception, such as we know it, is avoided. In the economy of insects, light is of extreme importance, as is indicated by the size and development of their compound eyes that have large receptive surfaces in comparison with the volume of the comparatively less-developed central nervous system.

The response of insects to various wave lengths of light, or colors, has been under investigation for many years. The early conclusions drawn from various experiments have been the subject of disagreement, particularly because of the difficulty in determining whether the apparent discrimination of colors by the insects was due to the intensity of the rays or to their wave lengths. The problem has been attacked by entomologists principally in two ways. Some observers noted the natural tropisms of insects, while others trained certain species to go to particular colors for food. Frequently, little or no attention was paid to the external source and mixture of wave lengths used in the experiments, and the results were described in terms of human color vision. However, a few investigators worked with known wave lengths in order to determine whether insects have color sensitivity and not merely sensitivity to light depending on intensity.

Sir John Lubbock established the fact that bees were apparently able to distinguish one color from another and could be trained to associate the finding of food with blue- or orange-colored papers. Auguste Forel accomplished the same thing with colored paper flowers. C. Hess projected a spectrum on a parallel-sided glass container that held imprisoned insects and observed that caterpillars and adults of the butterfly *Vanessa urticae,* and also bees, went to the yellow-green area, and that when disturbed from these areas returned to them. From these observations Hess concluded that, since totally color-blind persons see yellow-green as the brightest part of the spectrum, his insects were also totally color-blind. Hess also selected grays, the brightness of which matched the brightness of given colors, and found that when his insects were given a choice between a gray and a given color, both of equal brightness, they went to either one without discrimination or did not react at all, and from this he concluded that various colors are of the same relative brightness to insects as they are to totally color-blind persons and that insects lack color vision.

K. Frisch trained an Asiatic species of honeybee to come to a given color for food and to pick out that color from among others when no food was present. He used a series of pieces of paper of 15 shades, from white through various grays to black. The bees were then conditioned to some color, as blue, by associating that color with a sugar solution in a watch glass that was placed over the color. After conditioning of the bees was completed the blue paper, without food, was placed in various positions among the grays, and in every trial the bees gathered over the blue in search of food. After conditioning his bees to various colors Frisch concluded that bees could distinguish all colors except red and certain greens, and that these colors appeared to them as darker or lighter grays, and that, therefore, their color vision was identical with that of partially color-blind persons.

Various other workers, studying phototropisms, found that some insects preferred dark blue, others red and yellow, others green, etc., and their conclusions, agreeing with those of Hess and Frisch, were expressed in terms of human color vision, giving rise for a time to a state of confusion. In many cases no tests were made with ultraviolet, to which insects react, but which is

beyond the range of human vision. In addidition, some investigators covered their colored papers with glass. Light going through the glass was reflected back again, and the glass also reflected colors from near-by objects. Frank E. Lutz tested the colored papers used by Frisch and found that some of his greens and blues reflected ultraviolet, that his yellows and greens reflected blue and red, all of which invalidated Frisch's color scale for insects.

Little is known of the wave lengths with which the early investigators worked. In fact, many of them paid no attention to this aspect of the problem and interpreted the behavior of the insects in terms of human color vision, a practice which persists to some extent even to the present day. In 1881 Sir John Lubbock found that ants carried their larvae and pupae out of a region of relatively weak ultraviolet into one illuminated by longer wave lengths, and from this he concluded that colors as seen by insects were not the same as colors viewed by man. Later workers found that many other insects were photopositive to ultraviolet. Hess thought that the general sensitivity of arthropods to ultraviolet radiation was due to a fluorescence of the outer parts of the ommatidia, believing that the short waves were thereby changed to longer ones and that the animals did not have true ultraviolet vision. However, F. E. Lutz and E. N. Grisewood, using the cornea of a large flesh fly and of a honeybee, found that they were transparent to 2537 Angstrom wave-length units (A) and that such a wave length reached the inner elements of the eye. When the 2537 A beam was allowed to fall upon a mass of crushed Drosophila eyes there was still no fluorescence, at least nothing visible to humans. As time went on an increasing amount of attention was paid to the fact that color vision was a matter of wave lengths and a decided improvement took place in techniques and testing equipment. And ultraviolet was considered as a color, at least to insects. Most of the investigations with insects to date have been concerned with that portion of the radiant-energy spectrum from about 2500 A to 7200 A.

A. Kühn and R. Pohl trained honeybees to come for food in a narrow trough illuminated by ultraviolet of wave length 3650 A. After training, the food was removed and the entire spectrum was projected upon a sheet of white paper. Then the bees collected for the most part on the place subjected to the wave-length 3650 A. Frank E. Lutz also trained bees to come for food to a white card, reflecting ultraviolet wave lengths, and stingless bees (Trigona) to distinguish between ultraviolet patterns, one of which marked the site of their nest. L. M. Bertholf, in an extensive study of the reactions of the honeybee to the spectrum visible to us, found that for this insect the spectrum extended from 4310 A to at least 6770 A, the point of maximal stimulative effect being at about 5530 A. In terms of color, this means that the sensitivity of bees to light extends from violet to red, with the most stimulating part being the yellow-green. He also worked with different wave lengths in the ultraviolet spectrum and found that the stimulating effect was greatest at 3650 A for the honeybee.

In a study of the extent to which flower-visiting insects see ultraviolet, Lutz carried out tests in the field with numerous flower-visiting species. He put the insects into a rectangular box having a window at each end, which consisted of light filters that were interchangeable. He then put his head through an opening in the middle of the window, surrounded by a light-tight hood, and observed what was going on. Many of his test insects went from dark to clear glass, from dark to ultraviolet, from dark to blue, from blue to ultraviolet, from dark to green, from green to ultraviolet, from dark to red, and from red to ultraviolet, but when at ultraviolet they would not leave to go to clear glass. The conclusion is plain that many insects react positively to red, yellow, green, blue, and ultraviolet, and that they "see" ultraviolet better than other radiation wave lengths. Whether they "see" these radiations as colors or as different degrees of brightness is unknown.

During recent years thousands of insects, including larvae, involving over 50 species in several orders, were tested in lots of 100 or more in the laboratory by Harry B. Weiss,

Frank A. Soraci, and E. E. McCoy, Jr. Their insects were exposed to 10 wave-length bands of light of equal physical intensities, extending from 3650 A to 7200 A. The group behavior of these insects indicated that their peak sensitivity took place under the stimulation of ultraviolet at 3650 A. It then declined sharply toward the longer wave lengths, frequently with a secondary peak occurring from 4920 A to 5150 A (blue-blue-green). The remaining longer wave lengths to 7200 A were relatively unattractive to them. These investigators also found that wave lengths in the red end of the spectrum could be made as attractive as ultraviolet by increasing their intensities. Bertholf obtained similar qualitative results when he investigated the relative efficiency of different regions of the spectrum in stimulating Drosophila. He found that, beginning with the longer wave lengths, the efficiency was very low, but started to rise at about 5750 A (yellow) and increased to a maximum in the visible spectrum at 4870 A (blue-green). From there it declined to 4250 A (violet) and then rose to a peak at 3650 A (ultraviolet), which was five and one-half times higher than the first peak at 4870 A. From 3650 A there was a rapid decline to 2300 A. Various other investigators, including W. Sander and J. W. M. Cameron, found that their test insects were more strongly activated by ultraviolet (3650 A) than by any other wave length of equal energy. And the work of various economic entomologists, although devoted mainly to evaluating the comparative effectiveness of light-traps, has furnished additional evidence of the stimulating power of the shorter wave lengths and of the effectiveness of longer wave lengths under increased intensities.

There has been a great diversity in the type of equipment and in methods of persons investigating color responses of insects. The physical intensities of the wave lengths have been equalized by different methods. Sometimes they were unequal and the effect of equal energy was arrived at by calculation. The test wave-length bands varied from narrow to broad. The transmission characteristics of the color filters were either definitely or indefinitely known and the test insects were used either singly or in numbers. In spite of such variations, the test insects, on the whole, behaved with a remarkable degree of uniformity, and the following conclusions that appear to be true for insects in general may be drawn.

Many insects are sensitive in varying degrees to a spectrum extending from about 3600 A (ultraviolet) to about 7200 A (red). Drosophila is photopositive to 2537 A and the honeybee to at least 2970 A. Other insects may be equally sensitive to such wave lengths in the ultraviolet, but tests have not yet been made. Under the influence of equal intensities but different wave lengths, the most stimulating part of the spectrum is ultraviolet at 3650 A. From here it declines sharply to about 4640 A (violet-blue). Then it rises to a secondary peak near either 4920 A (blue-green) or 5150 A (green). Then it drops to 5750 A and levels off. Regardless of the relative positions of the wave-length bands, the group behavior pattern does not vary much from the pattern just stated. It has also been found that many insects will respond positively and in greater numbers to the shorter of any two wave lengths (between 3650 A and 7000 A) that are offered to them, where the physical intensities of both are equal and provided that the intensity of neither is great enough to repel them. Finally, what are unattractive wave lengths under equalized physical intensities may be made attractive by increasing their intensities. In other words, it is possible to vary the behavior pattern by varying intensities.

Up to the present, only the motor response of insects to equalized wave lengths has been considered, but substantially the same type of behavior is exhibited when the electrical responses of the compound eye during the process of photoreception in insects are studied. Such studies have been made by Louis Theodore Jahn and Frederick Crescitelli. According to these investigators, "Leads were taken with silver-silver chloride electrodes from fluid-filled chambers about each eye. The entire surface of one eye was illuminated and the other eye was kept in darkness. Records were obtained by means of a cathode ray oscillograph. For the ex-

periments on colored light, Corning color filters were placed between the light source and the eye." Six wave-length bands were employed, extending from about 4000 A to 7000 A. "The relative intensity transmitted through each of these six filter combinations was determined by means of a thermopile and galvanometer. The infrared radiations were completely removed from the stimulating light by using 5 centimeters of water and a Corning (AKLO) heat absorbing filter."

Jahn and Crescitelli also studied the change in form of the electrograms of the grasshopper eye under variations in intensity of the stimulating light and the quantitative aspects of the response in relation to the quality of the stimulating light. They found that there was apparently no specific effect of wave length on the electrical response of the whole dark-adapted grasshopper eye. At equalized intensities there were decided differences in wave form with the six different spectral bands, but these disappeared and the color responses were exactly matched when the intensities of the different spectral regions were properly adjusted. Quoting again from their paper: "The form of the electrical response of the dark-adapted grasshopper eye to brief stimulation by white or colored light varies according to the intensity of the light. At very low intensities the response is diphasic, the initial positive phase of which resembles the a-wave of the vertebrate electroretinogram. As the intensity is increased the positive phase decreases and changes its position while the negative phase becomes increasingly prominent. Eventually the positive phase is completely eliminated and the electrogram takes the form of the typical high-intensity response. The order of effectiveness of the different colors in causing this change in wave form is: green, blue, violet, orange-red, red."

The curve relating the magnitude of the potential to the wave length had a peak in the green region of the spectrum, and declined sharply toward the red and less sharply toward the violet. The magnitude of the electrical response was found to be definitely related to the quality of the stimulating light and the form of the response to be influenced by the intensity of the stimulating light, either white or colored.

Jahn and Crescitelli also studied, in the same manner, the electrical responses of the compound eye of the moth *Samia cecropia* in relation to the quality and intensity of the stimulating light. Part of their conclusions are as follows: "The electrical responses of the moth and grasshopper eyes to wave length are surprisingly similar. For both animals the same type of graph is obtained when the relative magnitude of the potential is plotted against wave length. This graph has a general similarity to the absorption curve of visual purple. Another aspect of the electrical response to wave length concerns the fact that no specific effects of wave length on the electrograms are discernible. By properly adjusting the intensity, the responses to one color may be exactly matched with the response to any other color, indicating that the differences in the responses to different colors of equal intensity are caused merely by differences in sensitivity and are not effects of wave length *per se*." In the case of the moth the maximum response was obtained with the green band. The responses dropped sharply toward the red band and less sharply toward the violet.

Although the king crab, *Limulus polyphemus,* is not an insect, the work of H. K. Hartline and C. H. Graham on the nerve impulses and responses of single visual sense cells to light in the eye of this animal is of unusual interest. The lateral faceted eye of the king crab contains about 300 large ommatidia, and the optic nerve fibers come directly from the receptor cells with no intervening neurones. These authors studied the nerve impulses and developed a technique by which they recorded the discharge from a single receptor unit in the form of oscillograms, representing the potential changes between the cut end and an uninjured portion of the nerve upon stimulation of the eye by light. The electrical activity in the optic nerve brought about by this stimulation was amplified by a vacuum tube and recorded by an oscillograph. Among other things, the stimulation of a single ommatidium resulted in a small strand of the

optic nerve showing a regular sequence of nerve impulses. "The discharge in a single fiber begins after a short latent period at a high frequency, which has been found to be as high as 130 per second. The frequency falls rapidly at first, and finally approaches a steady value which is maintained for the duration of illumination."

These authors also studied the responses of single visual sense cells to visible light of different wave lengths by means of single fiber preparations from a *Limulus* eye. It was found that when the energy of the stimulating light of different wave lengths was approximately equal, the response to green was stronger than the responses to either violet or red. When the energy was increased in the red and violet, their level of response was raised, and when the intensities for the different wave lengths were adjusted so that the responses were equal, there was no effect of wave length as such, indicating that single sense cells can gauge brightness but cannot distinguish wave lengths. The relative energies of the various wave lengths required to produce the same response after being adjusted in inverse ratio to the degree to which they are absorbed yielded a visibility curve, for a single visual sense cell, that had its maximum in the green near 5200 A and that declined symmetrically on each side to low values in the violet near 4400 A and in the red near 6400 A. According to the interpretation of visibility curves by Hecht and Williams, the stimulation of a single visual sense cell by light depends upon the absorption spectrum of the primary photosensitive substance. The absorption of light by this substance varies with wave length, and the production of a given response needs a certain amount of photochemical change, which in turn requires the absorption of a definite amount of energy.

Hartline and Graham also found that in the same eye of *Limulus* there was a differential sensitivity among optic nerve fibers and their attached sensory cells for different regions of the visible spectrum, and they believe that such specialization of the visual cells, coupled with integrated action, may give rise to color vision.

Thus the visibility curves of a single visual sense cell of *Limulus*, although not an insect, of the eye of a grasshopper, a diurnal insect, and of the eye of a Cecropia moth, a nocturnal insect, are qualitatively similar to the curve of the relative stimulating efficiency of different wave lengths of light for Drosophila, as reported by Bertholf, and to the behavior curves for the numerous adult and larval forms of diurnal and some nocturnal insects, as reported by Weiss *et al.* These curves are not identical because of the different methods of approach and technique, but they are all strikingly similar for the visible portion of the spectrum. All were obtained under wave lengths of equalized physical intensities. Hartline and Graham, and Crescitelli and Jahn, by properly adjusting the intensity were able to match the response to one color with the response to any other color, and Weiss *et al.*, in their behavior studies, found that insects responded to what were unattractive colors under equalized intensities when the intensities of these colors were increased.

Crescitelli and Jahn report that other authors who worked with pigeon eyes and the eyes of certain vertebrates also found that waveform differences are simply intensity differences and that the electrical response to different wave bands could be duplicated by adjusting the intensity of the different bands.

Thus it appears that both the electrical responses of the insect eye and the motor responses of the insect itself to different colors of equal intensity are due to differences in sensitivity, or to the absorption of light, which varies with wave length, by the primary photosensitive substance of the visual sense cells, and are not the effects of wave length by itself.

It appears from what has been set forth that although insects are sensitive to a spectrum extending from about 3600 A to about 7200 A, their motor responses and the electrical responses of their eyes, under laboratory conditions, indicate that they do not have color vision. On the other hand, in the field many species, especially those that are flower-visiting, behave as if they had color vision, although such behavior, if it is the result of vision alone, may be a response to brightness.

periments on colored light, Corning color filters were placed between the light source and the eye." Six wave-length bands were employed, extending from about 4000 A to 7000 A. "The relative intensity transmitted through each of these six filter combinations was determined by means of a thermopile and galvanometer. The infrared radiations were completely removed from the stimulating light by using 5 centimeters of water and a Corning (AKLO) heat absorbing filter."

Jahn and Crescitelli also studied the change in form of the electrograms of the grasshopper eye under variations in intensity of the stimulating light and the quantitative aspects of the response in relation to the quality of the stimulating light. They found that there was apparently no specific effect of wave length on the electrical response of the whole dark-adapted grasshopper eye. At equalized intensities there were decided differences in wave form with the six different spectral bands, but these disappeared and the color responses were exactly matched when the intensities of the different spectral regions were properly adjusted. Quoting again from their paper: "The form of the electrical response of the dark-adapted grasshopper eye to brief stimulation by white or colored light varies according to the intensity of the light. At very low intensities the response is diphasic, the initial positive phase of which resembles the a-wave of the vertebrate electroretinogram. As the intensity is increased the positive phase decreases and changes its position while the negative phase becomes increasingly prominent. Eventually the positive phase is completely eliminated and the electrogram takes the form of the typical high-intensity response. The order of effectiveness of the different colors in causing this change in wave form is: green, blue, violet, orange-red, red."

The curve relating the magnitude of the potential to the wave length had a peak in the green region of the spectrum, and declined sharply toward the red and less sharply toward the violet. The magnitude of the electrical response was found to be definitely related to the quality of the stimulating light and the form of the response to be influenced by the intensity of the stimulating light, either white or colored.

Jahn and Crescitelli also studied, in the same manner, the electrical responses of the compound eye of the moth *Samia cecropia* in relation to the quality and intensity of the stimulating light. Part of their conclusions are as follows: "The electrical responses of the moth and grasshopper eyes to wave length are surprisingly similar. For both animals the same type of graph is obtained when the relative magnitude of the potential is plotted against wave length. This graph has a general similarity to the absorption curve of visual purple. Another aspect of the electrical response to wave length concerns the fact that no specific effects of wave length on the electrograms are discernible. By properly adjusting the intensity, the responses to one color may be exactly matched with the response to any other color, indicating that the differences in the responses to different colors of equal intensity are caused merely by differences in sensitivity and are not effects of wave length *per se*." In the case of the moth the maximum response was obtained with the green band. The responses dropped sharply toward the red band and less sharply toward the violet.

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In view of the importance of ultraviolet as a stimulant, the effects of such wave lengths in sunlight and in the light reflected from foliage and flowers are of extreme interest. Observations by F. E. Lutz on about 100 flowers indicate that a majority of the "yellow" and many "red" and "purple," flowers are strongly ultraviolet. Few or almost no white flowers reflect ultraviolet, and few blue flowers are ultraviolet. Lutz photographed flowers through color screens and found that most of them reflect considerable green, that white flowers reflect large amounts of red, and that most yellow flowers are as strongly red as red flowers. Some authorities believe that ultraviolet reflected from flowers plays an important part in the sensation which certain flower-visiting insects receive when they "see" such flowers, especially in view of the fact that the ultraviolet energy of sunlight amounts to about one fifth of the sun's spectrum visible to such insects, and also in view of the fact that the shorter wave lengths of light contain greater amounts of energy than the longer wave lengths, and that photochemical reactions are produced more often by ultraviolet than by blue, and more frequently by blue than by green or red light.

On the other hand, little ultraviolet is reflected by green foliage, the maximum reflection from such being from 5400–5600 A (green-yellow), a region not particularly stimulating to insects when confronted under laboratory conditions by a spectrum of equalized intensities from 3650 A to 7200 A, but stimulating enough if the intensity is increased. As a group, insects apparently have little need to be able to distinguish colors. They are confronted mostly by radiation from the sun and sky and by the reflection from green foliage, and their sensitivity to wave lengths extending from 3650 A to 7200 A may make it possible for them to pursue their normal activities in the field regardless of constant fluctuations in the relative energy distribution of that part of the solar spectrum to which they are responsive. As a result they go about their business and are not unduly influenced by changes in the sunlight to which they are exposed. In view of this fact they would probably thrive in an ultraviolet world, or a blue world, or a green world, or a red world, provided the intensities of the colors were sufficient to initiate photochemical reactions in the primary photosensitive substance of their visual sense cells. As to whether or not they experience color sensations, this remains unanswered, but present evidence indicates that they are sensitive to and readily respond to different degrees of brightness regardless of color. Also, colors differ in the amount of stimulation that they give to insects. On the other hand, the training experiments of Frisch, Bertholf, and others, with bees, indicate that there are other effects produced by wave length differences.

THE SELF-MAINTAINING ORGANISM*

By EDWARD F. ADOLPH

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THE purpose of this paper is to outline in part a certain comprehensive investigation which has engaged me for some years. It concerns physiological regulations; the self-maintenance of organismal processes.

Anyone who looks at a table giving chemical analyses of the animal body, will note that water is the most plentiful constituent. It seemed to me that if one could understand how the water content of the animal body is maintained, he might thereby find a pattern for the maintenance of bodily components and functions in general. To a degree this has proven to be so.

Starting with water as a constituent of a living being, therefore, I plan here to indicate what happens whenever the bodily content of water is disturbed. Later, it can be shown that functions other than the control of water content are similarly organized. Finally, it is possible to suggest what these facts of organization mean for understanding the living being as a going concern.

The water content of a dog may be considered functionally. The water in its body is far from static, for it is being lost continuously by evaporation, although the dog's skin retards vaporization greatly as compared with a free-water surface. Most of the evaporation takes place in the respiratory passages, to saturate the warmed inspired air. Other water is continuously used to form urine and feces. All that water is replaced, by periodic drinking. The bare fact of replacement by drinking has been found to be an exact replacement; a quantitative relation between deficit of water in the body and amount of water taken at one draft (Fig. 1). The water is metered during alimentation and accords with the volume needed to remove the deficit in the body. The relation is simple enough; the construction and operation of the meter are at present beyond human knowledge.

* Presidential address before the Rochester chapter of Sigma Xi, May 2, 1944.

Lest anyone suppose that the alimentary tract is crucial to such a relation between intake and content, attention may be directed to the similar relation in the frog (Fig. 2). The frog sits in water, and takes

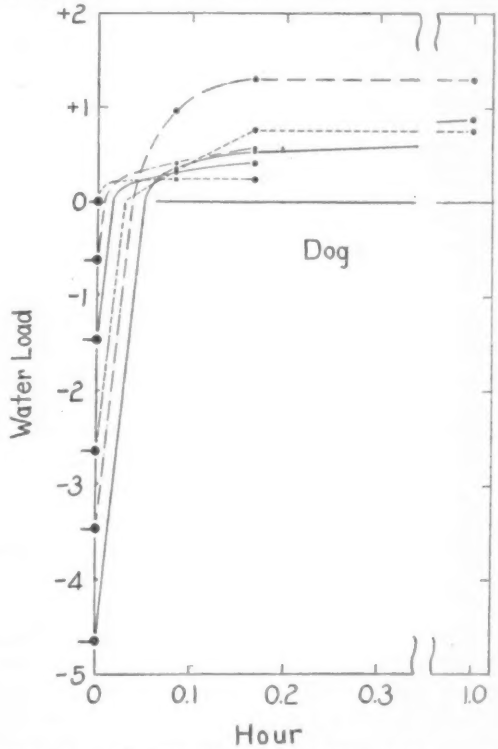

FIG. 1. AMOUNTS OF WATER INGESTED BY DOGS

WATER LOADS ARE IN % OF INITIAL BODY WEIGHT (B_0). 41 TESTS ON ANIMALS PREVIOUSLY DEPRIVED OF WATER TO DIVERSE EXTENTS ARE AVERAGED IN GROUPS OF 8 EACH. VOLUNTARY DRINKING IS AT TOP SPEED UNTIL CONTROL BODY WEIGHT IS REGAINED. ALL FIGURES ARE REPRODUCED FROM REFERENCE 3.

water in through the skin alone, again at a rate nearly proportional to the deficit of water previously established. The same has been established for earthworm and for one species of ciliate protozoan.

Having emphasized the prevalence of a relation, and de-emphasized the special proc-

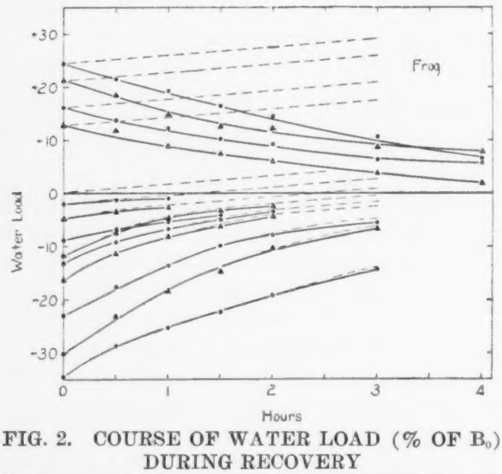

FIG. 2. COURSE OF WATER LOAD (% OF B_0) DURING RECOVERY

Rana pipiens RECOVERING FROM HYDRATION AND DEHYDRATION. *Solid lines,* TOTAL WATER LOAD (10 TESTS EACH); *dash lines,* GROSS WATER LOAD, INCLUDING URINE KEPT IN BODY BY LIGATURE OF CLOACA. DIFFERENCE BETWEEN SOLID LINE AND CORRESPONDING DASH LINE REPRESENTS TOTAL (URINARY) OUTPUT.

esses present in diverse species for executing it, I think it fair to suggest further that no organism would get along without this relation. This suggestion means that every species living has some means in constant readiness for gaining water when it is available, at a rate that is faster than usual whenever water deficit prevails. Such a general statement may seem to be a gratuitous hypothesis; it is demanded, if the belief is justified, that no organism can long survive without maintaining its water content. One thereby assumes that whatever individuals or species were unprovided with means of gaining water as needed ceased to exist. "There is not a single animal which could live or endure for the shortest time if, possessing within itself so many different parts, it did not employ faculties which were attractive of what is appropriate, eliminative of what is foreign, and alterative of what is destined for nutrition," Galen[1] said.

What happens, then, to an organism that has too much water in its body? Experimentally a dog has diverse amounts of water forced upon it by introducing the water in each test through a stomach tube. The response to all excesses of water is qualitatively the same; urinary output increases, and by an amount that eliminates most of the excess within three or four hours. Again a metered response is found, a precise correlation (Fig. 3) between rate of a process and content of water in the body.

The response of water excretion to water excess does not depend upon any special excretory organ. It is found in frog, insect, earthworm, and ameba, each of which has an emunctory different in structure from that of dog.

The relation between intake and deficit, and the relation between output and excess, can now be compared. Both deficits and excesses form a scale of water contents, water balance constituting the point between them. Both intake and output are rates of exchange and have common units. The combined graph (Figs. 4, 5; equilibration diagram) shows at a glance that the organism is protected both from excesses and from deficits. It is protected not only by virtue of faster exchange toward recovery (intake in deficit), but also by slower exchange by that process which would interfere with recovery (output in deficit). The organism seemingly cannot help but regain water balance. So would a reservoir for a city's water supply, or a toilet flush tank. We like to think in terms of

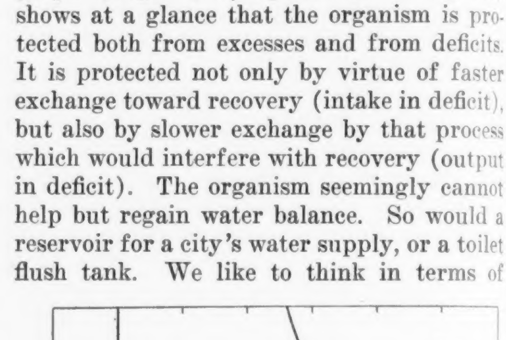

FIG. 3. COURSE OF WATER LOAD (% OF B_0) AFTER HYDRATION

DIVERSE SINGLE QUANTITIES OF WATER ARE GIVEN TO DOGS BY STOMACH TUBE AT ZERO TIME.

mechanical analogies; but they poison our minds when we infer that only a mechanical device could serve to accomplish the organism's trick.

All this arrangement or pattern or organization insures that the animal will recover its usual content of water after every disturbance of it. Actually, the arrangement is so good that the water content of the dog stays within one percent of the usual. That value characterizes the operations of this set of automatic relations. It represents a surprisingly small tolerance by an organism that has 999 other properties to govern at the same time.

Does it matter to the organism whether the water content is as usual or not? A dog or a man is debilitated by a deficit of water equal to six to ten percent of his body weight. He is convulsed by an excess of water equal to eight percent of his weight. He dies when either deficit or excess is double to triple this value. Somewhat larger departures from balance are tolerated only when salt and other constituents of the body accompany the water.

It might seem that the organism pinned its life upon the functioning of a tenuous relation among organs of exchange. And so it does; but the relation cannot fairly be called tenuous, for it operates everyday for scores of years in each of us, and not one in a million of us dies of dehydration or of water intoxication. Though not cast in iron with case-hardened bearings and triple communication systems, the organism survives the hazards of its water supply.

Equally immaterial are the arrangements by which the behavior of the dog or frog or earthworm makes water available when needed. No amount of internal regulation can take the place of mere availability of water to drink. Sensory and motor equipment of considerable extent is tuned to the task of finding water. Only when considerable water deficit is present does this task or drive become the predominant one. Then locomotion increases in rate, and sight, smell, and touch are used as guides to a source of water. If this behavior also seems tenuous, we yet recognize that it is so successful that dogs and men rarely die of dehydration. Some frogs and earthworms do, getting too far from moist ground, but not for lack of

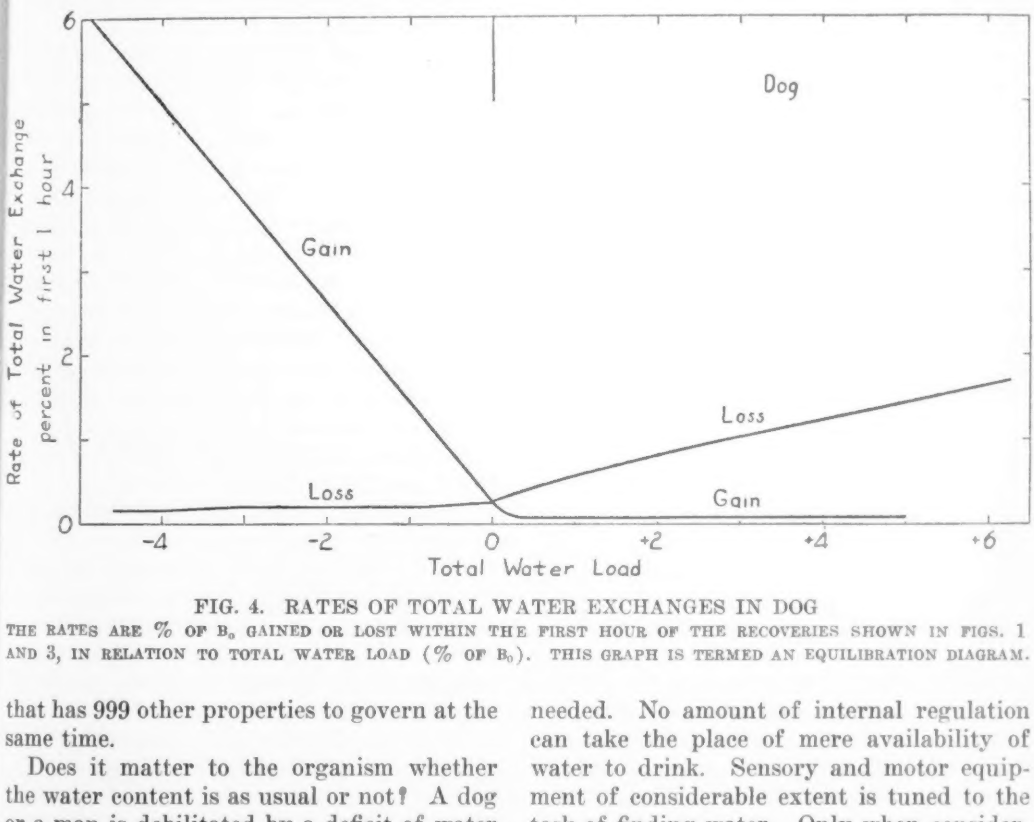

FIG. 4. RATES OF TOTAL WATER EXCHANGES IN DOG

THE RATES ARE % OF B_0 GAINED OR LOST WITHIN THE FIRST HOUR OF THE RECOVERIES SHOWN IN FIGS. 1 AND 3, IN RELATION TO TOTAL WATER LOAD (% OF B_0). THIS GRAPH IS TERMED AN EQUILIBRATION DIAGRAM.

useful behaviors toward water and water vapor.

In the whole attitude of the animal body toward water, no one can separate structure from function or process from behavior. All are knit together into a pattern of activities that works. No one can grasp that pattern who limits himself to the study of one sort of functional activity. For, the organism combines chemical, mechanical, and neuromuscular processes into a whole fabric that means success toward water. But the fabric is only a fragment if one arbitrarily confines his study to partial processes.

This account may suffice at present to describe the regulation of water content. Men have known the several facts of this regula-

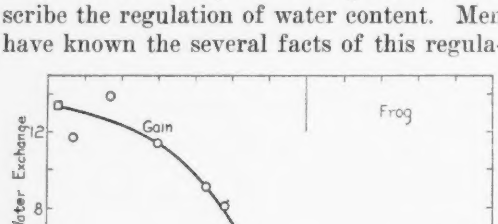

FIG. 5. RATES OF WATER EXCHANGES IN FROG

RATES ARE % OF B_0/HOUR, IN RELATION TO TOTAL WATER LOAD (% OF B_0). EQUILIBRATION DIAGRAM. RATES ARE ALL COMPUTED FROM FIRST ½ HOUR OF RECOVERIES OF WATER CONTENT SHOWN IN FIG. 2.

tion for centuries, and some of the quantitative details for seventy years. The present research consisted of putting selected facts together. It paid attention to *rates* of exchange instead of to forces concerned. The facts could go together in a dozen different ways; but only one choice of "variables" successfully represented the automatic aspect of the total processes. Mansfield Clark[2] challenges scholarship by asking: "Is knowledge a scrap-heap or an edifice?" "A goodly part of scholarship is the studious maintenance of balance between the advancement of knowledge and its consolidation." Only one grouping of the above facts resulted in an edifice.

Granting now that the physiologist can, by proceeding in the above manner, understand how the animal body is hydrostatted, has he described an isolated case, or has he possibly found a key to understanding also the other 999 sorts of bodily maintenance? He is interested not merely in chemical constituents; but as well in metabolisms, postures, excitabilities, movements. Each sort of those is also maintained. Certain of the maintenances can be shown to operate in a way as automatic as that for water content.

Heat exchanges of man or dog are patterned in a manner analogous to water exchanges. The equilibration diagram erected for water needs only to have different units for heat placed in it.[3] Evidently establishment of the pattern for water regulation has furnished a plan on which heat regulation can be quickly and easily understood. The same floundering need not be repeated before this field of physiology can be grapsed.

And so, there are patterns of maintenance for oxygen, carbon dioxide, glucose, and other biochemical constituents. Some show transformations to storage forms; some have multiple paths of disposal. Each has its metabolic peculiarities, yet its content in the animal body is secured by a series of equilibrating reactions and behaviors.

Nonbiochemical quantities fit the pattern. The frequency of man's heart beat, the pressure of blood in his arteries, the concentration of proteins in his plasma, the size of his liver, the frequency of his meals, all show equilibration. When any is disturbed, a compensatory rush of specific activity ensues. When any is put out of reach, increased efforts are put forward to bring it within reach again.

The study of water exchanges of the whole organism had a certain advantage for our understanding of equilibrations in general, by virtue of the fact that both gain and loss could be easily and directly measured. For water of the *blood* alone, gain could not be separately ascertained. For glucose, most of the gain and most of the loss are accomplished by chemical transformation within the body. As regards frequency of heart beat, gain and loss cannot be identified except by mathematical integration; a decrease of frequency means a cumulative deficit, its payoff is seen

only in the change of frequency itself. Obviously the description of equilibration of any one of these functions is less informing than one in which the constituent processes of exchange are separable.

Investigation has revealed, therefore, the widespread generality of the relation set up between rate of exchange and content of component. The specificity of relation is, in each case, that required for successful handling of the component. Elsewhere[3] the evidence for this statement is amplified. What I have described some physiologists would label a mechanism of homeostasis. A danger in having a label is that physiologists may be deterred by it from further investigation of the general relations involved.

It remains to say something about the properties of organisms that may be inferred from the fact that all these many components are handled side by side in the body.

In my school days, I recall, I wondered how an organism could possibly be automatic. A dog or a man was such a pliable thing; how could he keep each of his processes under control? Could he be a thermostat, hydrostat, phonostat, and equanimostat in a thousand dimensions? How could any one system or unit be protected from enough disturbances at one time to continue its independent existence? While looking after one requirement another would escape notice, it seemed. At the time I gave up the youthful vision to the guess that, since I by taking thought could not manage a thousand flying tricks at once, neither could the thoughtless body. Perhaps my difficulty was my supposition that thought was as economical a process as any; now I recognize that without thought more gigantic feats are accomplished, and painlessly, than ever materialized with it. Now, after carefully examining a few processes in some detail, I come back to the view that the dog or ameba is a unit, statted in a thousand dimensions, so fool-proofly that no one of the dimensions gets out of control within a lifetime, nor hereditarily within a geological era.

I see no exaggeration in the belief that a thousand functions are simultaneously equilibrated in a dog, in an earthworm, in an ameba, in a bacterium. Small size is no hindrance to the possession of the requisite number of checks and balances. Protoplasm may look labile to the eye, yet it is the only visible component of these immaterial steadinesses. Alone it is less than the instrument panel which is no substitute for the radar that can incorporate those instruments.

The great miracle of regulation is that all the equilibrations can be carried out simultaneously. Perhaps controlling machinery is not hard to set up, but provision must be made that when set up the various stats do not interfere with one another. The thousand of them are designed to coordinate. To only a small degree is water content disturbed when glucose or heat is adjusted. When, however, mutual disturbance results, a definite order of preferences is pre-established; thereby water may be expended to dissipate heat, but heat may not be appreciably retained to save water. All those inherent coordinations are a secret of the organism's success.

Every biologist has a right to speculate how these arrangements in the organism came about. How many choices did the organism have with respect to each of its thousand components? I would guess at least five qualitative ones—one to relate gain to excess, one to relate loss to excess, one to relate gain to deficit, one to relate loss to deficit, and one to relate gain to loss. That adds up to five thousand choices of procedures or of operations. Then each of the five thousand had to jibe with many others which may have required many times five thousand more choices. Was natural selection among random trials the means of evolution? Did all the million or more inadequate germplasms perish? It may have been so, but I often wonder whether there is not some guiding pattern by which the combinations of processes that click can add another one which clicks without trying at the same time all those that cannot click. Such patterns are recognized in nonliving systems as well as in animate ones.

The truism that organisms are largely self-steering or automatic seems not to depend on whether or not their actions correspond to some particular definition of vitalism. Darwin showed how a process of natural choice,

of inevitable adjustment, produced an apparent purpose or end. This was to some "a great mental relief," says Merz.[4] "It explained how it comes about that nature, even with unloaded dice, so often—yet not always—throws doublets."

All the above is not an utterly new chapter in physiology. Historically, attempts to grasp the nature of regulations are ancient and various. The earliest were among the Hippocratic physicians who recognized the tendency of the body to heal itself and who accordingly relied less on external remedies. The detailed investigation of bodily functions began only in the nineteenth century. Then von Baer and Bernard began to appreciate the intricate machinery that served to steady one after another of the properties of the body. Only with the end of the century was it realized that the background of natural healing was one in reality with the study of morphological adjustment and with physiological regulation (Driesch[5]). Thereafter the opportunity arose to record in quantitative kinetic terms exactly how much exchange was related to how much deficit. Emphasis upon the dimensions and the correlations has, I think, made the story concrete and intelligible.

But only a beginning has been made in the study of the physiological organism. Most of the interrelations among components and processes which I vaguely mentioned still remain to be defined. The allowances for activity, for temporary predominance of one process over another, need to be investigated. And by comparative studies perhaps we shall gain some notion of what occurred in the unrecorded past to sort out the possible relations into that particular assortment which is the automatic physiological organism. We may say with the great naturalist John Ray:[6] "I predict that our descendents will reach such heights in the sciences that our proudest discoveries will seem slight, obvious, almost worthless. They will be tempted to pity our ignorance and to wonder that truths easy and manifest were for so long hidden and were so esteemed by us; unless they are generous enough to remember that we broke the ice for them, and smoothed the first approach to the heights."

What I have tried to present is a set of data regarding the water content of the body in relation to water exchanges for the dog and the frog. Such relation was shown to be general for a variety of organisms. By it the maintenance of bodily water content was understandably concrete. Further, such relation was found to be general for a variety of functions and properties. Thereby a glimpse was obtained into the intricate interlocking controls that pictured approximately, though very incompletely, a pattern of the living organism as a going and self-controlled unit.

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ON THE FABLE OF JOE PYE, INDIAN HERBALIST, AND JOE PYE WEED

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WHO was Joe Pye, a man whose name has become a legend in American plant nomenclature? Was he a living character in the New England Indian population, or a mere phantom created by the rustic imagination of the colonists? The legend of an Indian medicine-man, named Joe Pye, curing the victims of a fever, typhus is mentioned by some, in early times is repeated by many New Englanders. He used a "weed" (*Eupatorium purpureum* Linn.) which took his name thereafter and found a status in the rural herbology of the Bay State. And garden-club botanists, and naturalists dealing with New England flora and folklore, have woven the legend into American plant history.

To an ethnologist the legend in question has significance. It has a bearing upon the discoveries accredited to native tribes which have benefited mankind at large, upon the broad field of aboriginal "natural science," and lastly upon the background of the American traditions that have built up our national character in the past three centuries. In this mood of inquiry we may now approach the topic.

We may well heed the admonition of Wm. Hamilton Gibson against contenting ourselves with being mere botanists—historians of structural facts. A wave of bold, realistic recognition of plant values in human history was about to invade the cloister precincts of old-school phylogenists and taxonomists.

At the time he wrote this a new branch was already sprouting from the main stem of learning in the broadest domain of the plant sciences; and that was ethnobotany. Most recently and most painstakingly a review of the gradual maturation of ethnobiology has been made the subject of treatment by E. F. Castetter (*The Domain of Ethnobiology*, American Naturalist, Vol. LXXVIII, March–April, 1944, pp. 158–70), to whom we may leave the burden of defining its scope and character.

The attention of the senior author was called to the question of identity of the Indian Joe Pye by a letter from Doris Appel, the talented sculptress of Lynn, Mass., who was fulfilling a commission for a series of heroic figures in stone to be placed in the Hall of Medicine of the National Museum in Washington. The series was to show in combined realistic and symbolic guise ten of the great contributors to the development of medical science of the world from earliest times to the present. She felt the urge to devote the first niche in the array of medical pioneers to the statue of a "primitive" healer typifying the very beginning of curative knowledge in human history. And her choice of a character to symbolize the dawn of knowledge in medical herbalism fell upon some American Indian medicine-man or doctor, if such a one could be found, to represent his race as discoverers of drugs and curative agencies derived from New World flora and as aboriginal American experimenters in medical progress. Mrs. Appel appealed to the senior author, in 1942, to suggest, through search in historical documents a personage whose history and fame might meet these requirements. Notwithstanding the failure on his part to find a suitable subject to serve as model for the likeness in stone, he did gain something from the attempt by learning more about Joe Pye, who at first seemed to be a possible candidate for the contemplated honor of immortalization in sculpture.

The bouquet of references culled from floral literature to grace the memory of Indian Joe Pye is not intended to form a final contribution to his unmarked grave. Here and there the naturalist ethnographer has repeated a version of the American backwoods classic. The following examples have

been encountered in the course of a summer's browsing amid the books on flowers and "weeds." Their wording is much the same—evidence of plagiarism. It would be pleasant to record the source of their origin in colonial literature. But such a pleasure is denied the writers for the present.

"'Joe Pye' is said to have been the name of an Indian who cured typhus fever in New England by means of this plant" (Mrs. Wm. Starr Dana, *How to Know the Wild Flowers,* N. Y., 1893, p. 210).

The same essayist a year later in a popular and appreciative approach to the wonders of plant life in natural history repeated her notice of the origin of the name without, however, indicating the source from which she took her information. Commenting upon the attractions of Joe Pye weed as a seasonal product in the wild bouquet of nature, she wrote, "It is said to have taken its name from an Indian medicine-man who found it a cure for typhus fever" (Mrs. Wm. Starr Dana, *According to Season,* N. Y., 1894, p. 107).

Thumbing casually through the literature of popular botany, we found another reference to the name of *Eupatorium purpureum,* Joe Pye weed, this time taxonomically classical and legendary for America as well. It comes from the pen of F. Schuyler Mathews (*Field Book of American Wild Flowers,* N. Y., 1902, p. 468); "Named for Eupator Mithridates, and for a New England Indian who used the plant in some concoction for the cure of fevers."

"Joe-Pye, an Indian medicine-man of New England earned fame and fortune by curing typhus fever and other horrors with decoctions made from this plant" (Neltje Blanchan [Mrs. N. B. Doubleday] *Nature's Garden,* Nature Library, Vol. 9, N. Y., 1907, p. 149).

The very latest reference encountered is that made by W. P. Eaton in the Boston *Herald,* Aug. 5, 1944, who writes on "Joe-Pye-Weed," saying, "Of course if you call it Joe-Pye-Weed you are perpetuating a legend only, of some Indian who employed this plant, so it is said, to cure fever."

The irrepressible Rafinesque now comes into the picture. In 1828 (C. S. Rafinesque, *Medical Flora, or Manual of the Medical Botany of the United States of North America,* etc., Phila., 1828), he gives the earliest reference to the Joe Pye legend to be found in print. Writing of Boneset (*E. perfoliatum*), he lists a vulgar synonym, "Joepye" (op. cit., Vol. 1, p. 174), and then adds (p. 179), "The name of Joepye is given to it, and to *E. purpureum,* in New England from an Indian of that name, who cured typhus with it, by a copious perspiration."

Seventeen years later, an exact repetition of Rafinesque's worded statement appeared in Peter P. Good's *Family Flora,* etc. (Elizabethtown, N. J., 1845, Vol. II, no p., article 51), without citing Rafinesque as his source. He also confused *E. purpureum* with *E. perfoliatum* under the English name of Boneset.

In the hope of finding some reference either to *Eupatorium* or to Joe Pye in the works of John Josselyn, the 17th century pioneer essayist in the field of American botany, a search through his *New England Rarities* (1672) and *An Account of Two Voyages to New England* (1675) yielded no data, even under the careful scrutiny of Prof. Tuckerman's detailed annotations. To what source earlier than Rafinesque the references to the fable repeated by later writers may be traced, we are still in the dark.

The original source of mention of Joe Pye as an existent person, and other references to the legend of the "weed" no doubt occur. Perhaps someone acquainted with early American botanical literature may supply the reference to its first appearance in print.

Many modern writers whose treatment of botany often combines popular features of sentiment and appreciation, folklore and fancy, with technical descriptions do not refer to the legend or to the source of the name. This is the case with Britton and Brown, *The Illustrated Flora of the Northern States and Canada* (1936), W. H. House (1935), E. R. Spencer *Just Weeds* (1940), all of whom pass by the story of Joe Pye and his antifebrile "weed." And the works of Gray are silent in the same respect. That T. F. T. Dyer in his *Folk-Lore of Plants,* N. Y., 1889, does not mention it is not strange for he was an Englishman. The medical botanists of the last century, W. P. C. Bar-

ton, *Vegetable Materia Medica of the United States,* Phila., 1818, J. Bigelow, *American Medical Botany,* Boston, 1817, and R. E. Griffiths, *Medical Botany,* Phila., 1847, also failed to note the legend.

Why the Joe Pye weed should have acquired the names it carries in different parts of its range, Skunk weed, Marsh Milkweed, Trumpet weed, Purple Thoroughwort, Indian Gravel or Kidney-root, Nigger weed, Quillwort, Motherwort, Tall or Purple Boneset, and King- or Queen-of-the-Meadow, as its synonymy reveals, raises other questions of European associations in folk botany. Incidently, the name "Joepye Weed" is apparently used only in a rather narrow area, stretching from eastern Massachusetts to western New York. North, south, and west of this area it is known by various of its other names, but it is, however, only the connection of the distinctly American plant with the mysterious, distinctly American personality of Indian Joe Pye that we choose to examine now.

Was Joe Pye, or the family bearing his surname, ever noticed in the genealogical literature of the New England tribes? Have the traditions surrounding the name and the plant been collected and discussed as historical facts or fancies?

An answer to the first query may be found in at least one dependable reference which we desire to call to the attention of botanical folklorists and historians.

The key to the solution of the mystery of Joe Pye's family authenticity among the Indians of New England of over a century ago is to be found in W. DeLoss Love, *Samson Occum and the Christian Indians of New England,* Boston, 1899. In the Connecticut Historical Society archives is preserved a diary written by Samson Occum, the Mohegan Indian convert of Connecticut who served the missions to the Brothertown and Stockbridge Indian bands in the Oneida country, in the state of New York (1786) and who was instrumental in the foundation of Dartmouth College. Occum made an entry in his personal diary July 14, 1787, saying "Some(time) in the morning went to see Joseph Pye, alias Shauqueathquat, and had a very agreeable conversation with him, his wife, sister and another old woman . . ." (Love, op. cit., p. 266). In 1789 Joseph Pye is again referred to in the chronicles of the Mahican mission at New Stockbridge as accompanying Joseph Quinney, another officer conspicuous in the history of the Stockbridge tribe (Love, op. cit., p. 281). The particular circumstances that led to mention of a Joseph Pye in this period of Indian migration which witnessed the removal of so many of them from Massachusetts, Rhode Island, Connecticut, and Long Island to new mission locations in central New York among the Oneida, are not pertinent to the purpose of this account. It is sufficient to note that in the last quarter of the 18th century an Indian named Joseph Pye was so relatively prominent in the Stockbridge tribe as to have merited historical notice. Be it recalled that the said tribe was composed of families drawn from the region adjacent to and west of the Connecticut River in its course through Massachusetts. Hence it follows that Joseph Pye of the chronicles was a descendant of the Indian family Pye stemming from the State of Massachusetts. It requires no stretch of imagination to ignore the assumption that his name and that of the mysterious Indian Joe Pye of "New England" who brought *Eupatorium purpureum* to assuage the fever of the colonists, is an accidental coincidence. The Indian natives of Massachusetts had adopted the English system of family surnames from the time of John Elliot, their apostle, more than a hundred years before the J. Pye of the 1787 reference. It follows that the latter bore the name of a direct paternal ancestor who dwelt in some part of the same state. That the J. Pye of 1787 could, however, be the same individual whose name and legendary beneficence are perpetuated in the herbal tradition so early and so widespread is quite unlikely. They could more reasonably have been grandfather and grandson, members of an Indian family residing anywhere between Massachusetts Bay and the Connecticut Valley.

Lest this brief communication be burdened with a mass of irrelevant data, we may conclude the historical résumé by affirming the tradition of existence of an Indian named

Joe Pye in the colonial period of the Massachusetts Bay colony.

Current sources of folklore concerning plant medicines are not silent in eastern New England. Traditions die hard among the people of the back country, especially if they smack of picturesque romance in the days of early settlement. An example of how the colonial saga of Joe Pye weed has been handed down among rural herbalists comes recently from William Luscomb, a native of Essex County, on the northeastern coast of Massachusetts, of Indian extraction. "Catnip Bill," as he is called in Gloucester and Essex, near where his wigwam of old sails, mats, and linoleum is located, is an herb-gatherer and itinerant Indian "doctor" over 80 years of age. We know him well. When approached and questioned about the story of Joe Pye weed, he became eloquent. He proclaimed in effect that Joe Pye was an Indian medicine-man who lived near Salem (Massachusetts) in colonial times, that he owned a large tract of land, that he taught the settlers to use "Joe Pye weed" to cure fever, that eventually he was crowded out of his land without pity by the whites whom he had befriended. So he had heard it from his father who was also an herb-doctor. Needless to add he, like others of his class, had more to comment upon in reference to the injustice of the whites. As to the fate of poor Joe Pye, Catnip Bill only knew that he had finally given up and moved away, which meant westward to Indian towns in the less settled districts of the state's interior.

Since the indications pointed to old Salem as a center from which the fable may have spread, we hopefully searched the local histories, but Joe Pye remains an unmentioned character in published town history, and in Essex County botanical records. One search covered the works of C. H. Osgood and H. M. Batchelder (Salem, 1879), J. D. Phillips (N. Y., 1933), S. Perley (Salem, 1928), and C. H. King, (1822–66, Brattleboro, 1937), all historians and folklorists of the county, and that of the botanist J. Robinson (*The Flora of Essex County,* Salem, 1880).

Not to overlook a possible clue to the meaning of the family name Pye in the native idioms of Massachusetts and New England as a whole, we may say that it seems at present etymologically insoluble. Without knowing what degree of corruption the original pronunciation of the term suffered through being sounded by English tongues and written out by English scribes of the period, it is baffling to relate the simple term to any plausible equivalent in New England Algonkian languages and dialects. It looks like a shortened form of a longer name-title such as was frequent in the Indian personal and family surnames of the region. That it could have been a nickname derived from English "pie" does not appeal to an ethnologist's view of the case. To our knowledge there is no family among the Indian survivors in New England that bears the name Pye. And finally, since the last speakers of the Mahican language spoken at Stockbridge have died, there is no living source among the Stockbridge Indians of today who could explain the personal name *Shauqueathquat,* noted by Samson Occum in 1787, as an alias for the Joseph Pye that he knew then.

SOVIET GENETICS AND THE "AUTONOMY OF SCIENCE"

By LEO KARTMAN

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DR. MICHAEL POLANYI's article in the February SCIENTIFIC MONTHLY clearly indicates the historical forces which have been operative in the development and dissemination of science. Under the title, "The Autonomy of Science," the author poses a problem which has now become of prime importance not only to science but to every ramification of human social existence. Basically, this question is concerned with the contradiction between the theory and practice of individual control as against the practical ideology of state or collective control. This struggle between the two most fundamental forces of contemporary industrial society gained its greatest impetus, perhaps, from the impact of the October revolution which transformed Czarist Russia into its own antithesis. Since that cataclysmic event this controversy has entered and penetrated and colored every shade of our thinking so that it emerges even in many of the most trivial aspects of daily life. Dr. Polanyi has indicated its present importance to the future of science not only through a historical resumé, but also by means of a discussion of state control in the Soviet Union. These observations, coming from a scientist of his calibre, must be seriously analyzed since they surely carry considerable influence.

If I interpret his view correctly, Dr. Polanyi has attempted to show that the health of science depends primarily upon the degree of independence it enjoys in the task of choosing and conducting its research and the degree of free public discussion concerned with scientific concepts and conclusions. He suggests that "any attempt to direct these actions from outside" will bring about a state of disorganization which can only create a condition in which "the main body of science itself would disintegrate and fall into oblivion." By outside influence, I understand him to mean the direction of scientific work by non-scientists who are technically ill equipped to evaluate scientific problems, the trends of scientific thought, and the types of necessary research at any given moment. A state policy which allows such persons to direct scientific programs is thus negating all the conditions which have been responsible for the consistent growth of science during the past 100 years.

That the affairs of science should be managed by scientists is axiomatic and needs no further discussion here. That scientific progress has been "swift and steady" during the past century of its "independent" growth is, generally speaking, a valid observation and would be impossible of negation. That the future development of science is contingent upon a permanent state of "autonomy" is a moot point which I shall not argue at this time. (The position of science in industry, under civil service, and under war economy suggests, perhaps, that the basis for scientific progress may be changing quite radically even in those countries "where science is still free.") I am concerned here specifically with examples of state control and, for the sake of argument, I am assuming that state control is *à priori* productive of evils the presence of which leads to the death of science. The argument, then, is not whether state control is desirable as against individual control; the argument here relates to the problem of the *examples chosen* by Dr. Polanyi to prove his point that science is subverted by "attempts made to break the autonomy of scientific life and to subordinate it to State direction."

It would be difficult, if not impossible, to show that the state domination of science in fascist countries, especially Nazi Germany, has resulted in anything but a frustration of scientific research, a distortion of the legitimate aims of science, and a negation of scientific spirit. Dr. Polanyi's quotation from Himmler and his observations concerning recent German "scholarship" are well

taken. However, the main example of corruption brought about through state interference, cited by Dr. Polanyi, is concerned with certain developments in the growth of Soviet genetic science. This circumstance, I wish to urge, is an unfortunate one which detracts greatly from the value and validity of his case. Had he chosen to discuss the serious ramifications of principles laid down by Nazi "official science" his argument would have emerged forceful and convincing. The choice of the U.S.S.R., it would appear, vitiates fundamentally the cardinal *raison d'être* of his thesis. I shall attempt to show the reasons for this assertion.

In the first place, it must be made clear that the choice of the Soviet Union as against Nazi Germany is dependent upon the idea that "the attempts of the Soviet Government to start a new kind of science are on an altogether different level" from that of the Germans. He then reasons that since the Soviets are genuinely interested in creating a science for the public good the status of science in that country should provide the most adequate example of the principles of state control in operation. This is certainly a valid argument and it correctly, though superficially, implies a distinction between types of state control on the basis of motivation and subjective good faith, at least. (That there are more fundamental differences between a fascist dictatorship and a socialist dictatorship cannot be discussed here; it is unfortunate that this distinction was not emphasized since it is basic to the whole argument.)

The sole example cited by Dr. Polanyi concerns the genetics controversy in the Soviet Union which culminated in a national conference in which the two principals were T. D. Lysenko and the well known geneticist N. I. Vavilov. I unfortunately do not have any material on these discussions at hand; at any rate, I remember that, at the time, the reports in the American press were highly distorted and colored in attempting to promulgate the idea that Stalin was destroying formal genetics by clamping down on Vavilov and other so-called "orthodox Mendelians." Actual accounts of this conference showed that it was a nationwide discussion between the proponents of "vegetative hybrids" and the defenders of cytogenetics. It is Dr. Polanyi's contention that Lysenko's views won out and that the stage had been set for this victory of stateism and incompetence as far back as 1932 when it was decided that "genetics and plant breeding should henceforth be conducted with a view to obtaining immediate practical results and on lines conforming to the official doctrine of dialectical materialism, research being directed by the State." Furthermore, he goes on to show that the success of I. V. Michourin in producing new varieties through grafting laid a basis for the idea that new strains may be inherited independent of the germ plasm through a process of "vegetative hybridization." It is also shown that, previous to the conference, Lysenko had gained a large reputation and following and that he was appointed to important scientific posts in which capacity he was in a position to direct research. The influence of Lysenko, it is pointed out, caused many farmers, young students, and others without scientific training, to attempt experiments of one sort and another which they reported in journals and which were sanctioned by "gullible practitioners and politically minded officials."

It cannot be denied that such excesses of unscientific activity actually took place in the Soviet Union. The facts which Dr. Polanyi cites are substantially correct. That Soviet genetic science has been shattered by these events is, I submit, a complete distortion and misrepresentation of those facts. The advent of Lysenko and his school was nothing more than an episode, a passing phase in the development of Soviet genetics. I shall try to explain the reason for this below. At this point let us first cite responsible evidence that Soviet genetics is not only alive, but has continued along a course parallel to our own development in this field.

I have before me a volume of addresses made by eminent American scientists before the Congress of American-Soviet Friendship which was held in New York on November 7, 1943. Among a host of presentations was one by Dr. L. C. Dunn, of Columbia University, on Soviet work in biological science with special emphasis on genetics. Dr. Dunn, in an early portion of his paper, says:

> The great vitality of Soviet biology is nowhere better evidenced than in my own field of genetics and its close relative, cytology. Here there is no doubt that the most important contributions have been coming from the U.S.A. and the U.S.S.R., and in the number of workers, of institutes and in quality of work these two countries are comparable. Genetics has been recognized in Russia as one of the disciplines underlying agriculture and medicine and has received a large measure of support.

It is quite clear that this famous geneticist has reference to classical cytogenetics and not to the theories of Lysenkoism. The development of genetic research has continued unabated to the present time—let us quote another passage from Dr. Dunn's address:

> In 1921 the American geneticist, H. J. Muller, took to Moscow strains of the vinegar fly *Drosophila* and there grew up the greatest center of theoretical research in this field outside of the United States. . . . Out of Soviet genetics have come also new ideas of chromosome structure, of the origin of mutations and new ideas on the arrangement and relations of the hereditary particles, the genes, by very many workers. *By 1940 Moscow had in fact become one of the most important centers of work of this kind.* (*Science in Soviet Russia*, pp. 28–34.)

The impression gained from these passages is certainly not a picture of the disintegration of Soviet genetics under the aegis of state planning and state control. The writings of H. J. Muller, J. B. S. Haldane, and other well-known geneticists substantially support Dr. Dunn's contentions. A country which has produced such brilliant and world-renowned geneticists as Vavilov, Dubinin, Timofeef-Ressovsky, Dobzhansky, Gershenson and others can hardly be said to be favorable to ideas which are destructive of the accepted notions in genetics or any other branch of science, for that matter. Dr. Dunn tells of a letter he recently received from Professor Gershenson, director of the Genetics Institute of the Ukranian Academy of Sciences at Kiev, in which is cited the terrible destruction to the institute by the war. Gershenson asked for American publications and stocks of *Drosophila*. This clear indication of the vitality of Soviet cytological genetics (if it needs any defense) is further strengthened by the fact that:

> . . . in this third year of Russia's participation in the war, she is still the largest foreign subscriber to the chief American scientific journal in this field. More copies go to the U.S.S.R. than to all other foreign countries. Moreover, a standard American text-book which appears in the United States in editions of 2,000 copies is printed in the U.S.S.R. in editions of 15,000.

It is sufficiently evident, I think, that no substantial case can be made out against state intervention on the basis of circumstances surrounding Soviet genetics. Dr. Polanyi has fallen into the not uncommon error of allowing Soviet excesses to color his view of what is really basic. It must be understood that the October revolution released a fund of energy which found its chief source of creativeness in the engineering of change. Every phase of human life, from the most intimate and personal factors to the largest state problems, has been dominated by the desire to liquidate the old ways, the fetters of decadent Czarist and reformist ideas. In such a spirit it is not surprising to find extremes in every field—and that is exactly what happened. Public education went to extremes suggestive of anarchy under the Dalton plan; marriage and divorce laws became exceedingly lax; the various leagues of "the Godless" carried on their work with an unparalleled sectarianism and myopia; there were excesses in criticism of all kinds, from self-evaluation to the public criticism of actors, composers, scientists, and factory workers; millions of little people, sincere and enthusiastic, were fired by the march of new ideas, and change itself became an obsession which they misinterpreted as the practical expression of dialectical materialism.

Such is the context in which we must view the Lysenko affair and the temporary entertainment of ideas which did not square with the established principles of cytogenetics. Every geneticist is well aware of these facts, but there are few, if any, competent geneticists who would argue that Soviet genetics has been rendered impotent by state control through the sanction of Lysenkoism or Michourinism. The new varieties developed by Michourin were on a par with the work of our own Burbank. If the Soviet Union sees fit to honor Michourin and rename a town Michourinsk, we have our town of Burbank in California and have heaped honors upon the man whose name it holds. Many popular science writers and many people in the United States have confused Burbank's

work with that of fundamental genetic research. That fact has not made our genetic science any the poorer and Burbank's influence has certainly not undermined the standing of the work of Morgan and his school.

Lysenko's inordinate enthusiasm to become divorced from formal genetics and to break away from Mendelian ideas stems directly from that national preoccupation with change and revolution in all things. Soviet materialistic philosophy had emphasized the importance of the environment as a factor in determining social and political ideas and conceptions of art, literature, etc. This tenet found expression in biological work as well, especially since it was reinforced by Pavlov's work on conditioned reflexes and by the practical application of this theory to human character development in the work of John B. Watson and his behaviorist school in America. Lysenko and his followers became enamoured of the principle of environmental influence and carried it to an extreme. A combination of political philosophy and the valid biological principle that changes in the environment of the embryo may produce marked aberrations—that "a character is always the joint product of a particular genetic composition and a particular set of environmental circumstances"—caused Lysenko to apply poorly digested political and scientific knowledge in a mechanical way. Some of the things he did were productive of practical results, just as work in other countries, on the selection of phenotypic varieties, has produced useful economic plants. It may also be possible that during the course of selection experiments genuine mutants were selected and not recognized as such. Lysenko was blind to the significant fact that the principle of dialectics finds its own validity in the prevalent concepts underlying cytogenetics rather than antiscientific extremes which created a principle out of an obsession for change. In the words of the great Soviet biochemist Bach:

> It would be a mistake to think that, in setting itself practical aims, Science in the U.S.S.R. neglects the solution of theoretical problems; quite the contrary is true, Soviet scientists strike for a happy combination of theory and practice and for their interaction.

This has not been the place for a discussion of the more basic aspect of Dr. Polanyi's thesis that science must remain autonomous to survive. Such men as J. D. Bernal, H. Levy, J. B. S. Haldane, J. G. Crowther, Henry Sigerist and others have written books and articles upon the subject which seem to indicate that Dr. Polanyi's argument is basically unsound. That is to say, his thesis is unsound in application to *all forms* of state control while it is undoubtedly valid in reference to specific types of which fascism is the best example in the contemporary world. In attempting to show the evils of state planning on the basis of the analysis of a mere historic incident he has not only weakened his case but has shown a degree of uncertainty regarding the question of what constitutes state planning, not in a vacuum, but in any given type of existing economic system. His article has correctly emphasized the esoteric nature of science and he can lay claim to having defended the thesis that science must be planned by scientists. He has not proven the claim, however, that Soviet genetics is an instance of a moribund science rendered asunder by state control. Close study of the matter will show precisely the opposite condition to obtain. We can do no better than close this discussion with a quotation from Harlow Shapley of the Harvard College Observatory. In a brilliant article which makes a strong plea to American scientists for collective scientific planning, he says:

> You will need to ask yourselves whether we in America are still young-minded enough, and socially minded enough, to work in this way for a common national and human good. Or should we leave dreams such as this to those national groups where there is no hesitation in making five-year plans, social, economic, scientific, and where the plans are carried out and progress made premeditatively toward the transformation of a national culture?

Genuine scientific progress, like the struggle for international peace, is indivisible. It cannot long tolerate conditions which tend to subvert its very foundations. Countries have had their pseudo-science, their mistaken theories, their excesses and extremes, their Lysenkos and Michourins. The test of the permanence of spurious ideas and the domination of imposture is the test, not of state control *per se,* but of the type of political and economic system that holds the reins of control.

SCIENCE ON THE MARCH

SOME NUTRITIONAL ASPECTS OF GREEN LEAFY VEGETABLES

The inclusion of numerous "protective" foods in our daily diet has been the nutritionist's common recommendation in recent years. Leafy green vegetables are among these particular foods. They are recommended, not for their contributions of protein and calories, but, mainly, for their minerals and vitamins. Consequently, we should take cognizance of those factors modifying these particular nutritive values in these fresh garden vegetables.

We have been prone to gauge our daily diets in terms of one or two servings of greens. We have, as yet, given little or no consideration to the inherent nutritional differences in these because they are of different plant groups, or to the induced variances in the same crop when it is grown on soils differing in fertility. Marked variations in vitamin and mineral contents have been observed in these crops as a result of their diverse genetical groupings, and of growing them under controlled, but variable, levels of soil fertility, determining the resultant plant composition.

With the exception of lettuce and a few minor crops, the green leafy vegetables are classified botanically as belonging to either the goosefoot (Chenopodiaceae) or mustard (Crucifereae) family. The former includes spinach, Swiss chard, and beet greens, while kale, turnip greens, collards, and mustard greens comprise the latter group. Nutritionally, with respect to their ultimate mineral contributions, the two families differ sufficiently to warrant a more careful discrimination in their use than is now commonly made.

Perhaps no vegetable has been maligned more than spinach. This is true in spite of "Popeye, the Sailorman," who has been clothing its consumption with strong appeal. Without undue disparagement of the nutritive qualities of spinach, it is unfortunate that such publicity could not rather have suggested the more popular use of kale, turnip greens, or some other member of the mustard family.

Of late the relative availability or digestibility of calcium and other minerals in leafy vegetables has been an item of concern. In all members of the goosefoot family and with one other related crop, New Zealand spinach, sizable quantities of oxalic acid make doubtful the dietary utilization of the plant's most important mineral components. Such vegetables may be worthless as contributors of calcium and magnesium and, in addition, may render unavailable a large percentage of the same minerals normally furnished by other foods in the diet such as milk.

Whereas the mineral contribution may be negative in spinach and its relatives, the vegetables of the mustard family are practically free from oxalic acid. They can, consequently, be recommended for their large amounts of readily assimilated basic minerals as well as their vitamin content, which generally exceeds that of the high oxalate-containing plants. These nutritionally superior greens are easily grown under a variety of climatic and soil differences. In addition, they have a long growing season. With most people there can be cultivated for them a liking and preference, certainly equal to that for spinach.

Not only do nutrient differences occur in leafy vegetables as a result of botanical relationships, but of increasing importance, as a determining factor in the dietary value of a given crop, is the fertility level of the soil growing it. Marked variations in chemical composition have been noted when spinach, Swiss chard, and New Zealand spinach were grown in sand-clay mixtures supplied with variable amounts of plant nutrients.

The outstanding effects so far have resulted from nitrogen. The excessive or even moderate use of nitrogen fertilizer salts, under our conditions, has given substantial reductions of as much as 60 percent in vitamin C, calcium, and phosphorus. Statistically these differences have proven significant far beyond the one percent level.

With respect to oxalic acid, it has been repeatedly demonstrated that the concentration of this organic compound in the crop increased as more nitrogen was provided in

the soil. In Swiss chard, oxalic acid production at all fertility levels was in excess of the combined chemically equivalent quantities of calcium and magnesium. The surplus of oxalate was progressively of greater magnitude as the soil nitrogen supply was increased and calcium decreased.

The influence of soil fertility on mineral and vitamin contents and thus its more indirect effect on the production of plants resistant to or unsuitable as food for insect pests was recently noted in a series of striking observations of selective injury on New Zealand spinach by the common greenhouse thrips (Heliothrips haemorrhoidalis). With 320 plants in the experiments, the insects, though free to choose whatever plants they wished, invariably selected as food those low in nitrogen. It was also of significance that when the soil's calcium supply was increased the insect attacks on the low nitrogen groups were less serious.

Many insects have, without question, definite attributes for food selection. This differentiation has been observed by us among plants of a given variety grown on soils differing in fertility. Similar discriminations are equally obvious between botanical groups. The goosefoot family and New Zealand spinach, objectional to man as food sources for calcium, are relatively free from insect attacks, while, in contrast, members of the mustard family are commonly infested with numerous parasites. These lower forms of animal life, unbiased by modern dietary propaganda, seemingly demonstrate more judgment in their choice of food than does man in his adherence to the directive of the two green leafy vegetables daily, regardless of kind or nutritional quality.—S. H. Wittwer, Missouri Agricultural Experiment Station, Columbia, Missouri.

THE DEVELOPMENT OF SOCIAL NESTING HABITS IN CUCKOOS

Cuckoos have long been famous for announcing the hours of the day, but they have another accomplishment not so commonly known—that of laying eggs in the nests of other birds. Of approximately 200 species in the family about 80 are known to parasitize the nests of other birds. Some species appear to be just starting on the road to such parasitism, and lay eggs only rarely in nests of other birds. Other species have developed the habit further to the extent of never building their own nests but always laying their eggs in the nests of other birds. A few species have advanced to the point of laying their eggs in the nests of only one other kind of bird.

One small group of cuckoos, instead of developing the habit of social parasitism, has become communistic. The birds associate in flocks of about a dozen individuals, spending the days together and sleeping in the same tree. At the breeding season the members of the flock cooperate in the building of a single nest in which several females may lay and incubate eggs. The males assist in the construction of the nest and in the care of the young. After the breeding season the young stay with the flock for a variable length of time, may help in the care of the next brood, and may even breed with the colony the next season.

These communistic breeding habits have developed in a small group of four related kinds of cuckoos called anis living in Central and South America. The most primitive of these communistic birds, *Guira guira,* live in loosely-knit flocks. The birds form pairs which may separate from the flock to nest or may join with other pairs. The development of communistic habits continues in the bird *Crotophaga major.* These birds associate in small groups and several pairs join in building one nest. The climax is reached in the two species, *Crotophaga ani* and *C. sulcirostris.* These two birds have somewhat different ranges but very similar nesting habits. The marital relations are very flexible. Frequently one bird has several mates. In some cases it is certain that a female consorts with several males and in other cases one male mates with several females. All birds assist in building one nest and in caring for the young. All the parents bring in food and give it to the young. Some females which had not laid eggs carried caterpillars to the nestlings. The development of this social nesting is probably the result of several influences in the history of the group.

One important factor in the evolution of

communistic nesting is the modification of territorialism. The concept of territorialism has developed from attempts to interpret various types of fighting behavior in animals. Briefly stated, the idea of territorialism implies the defense of a chosen area, usually the nest site and surrounding land, against members of the same species. For example, many birds defend a plot of land by fighting and singing to threaten possible invaders and drive out interlopers at once. The nest is built in the area and there the young are reared. In all the species of the communistic cuckoos the colony owns a territory which consists of two distinct sections. One part is a clump of trees for sleeping and the other is an area of fairly open land for feeding. From the communal territory, in general, other members of the species are expelled.

Intruders are threatened and driven about the territory in furious "dog-fights." The birds use a special call to indicate that an aggressor has entered the territory and then the whole flock attacks and chases the interloper, sometimes for as long as 2 days. In some cases the stranger eventually is accepted into the flock. If a stuffed bird is fastened in a tree the owners of the land attack and soon demolish the dummy. An amusing experiment is to put a mirror in a conspicuous place and watch the birds attack their own image and attempt to drive the "stranger" away.

Among the kinds of communistic cuckoos, however, certain differences in the maintenance of territorialism exist. *Guira guira* defends its territory only slightly. Numerous intrusions are permitted. The important point is that within this colonial territory one or two pairs may have their own small territories. However, the defense of this small territory is not vigorous and in many cases other individuals of the colony use the nest, thus producing a communal nest. At the next stage of development, as exemplified by *Crotophaga major,* the birds remain in pairs and all cooperate to build one nest in which several females lay eggs. The flock defends the territory. In the last stage of evolution, shown by *Crotophaga ani,* each colony defends its territory most aggressively and without exception attacks strangers. The greatest innovation at this climax of development is the disappearance of the habit of pairing. Copulation is quite promiscuous; a female has been observed on several occasions to consort with various males and a male may accompany any female. In these three stages the phylogenetic development of social nesting coincides with the disappearance of territorial defense by the pair and the appearance of territorial defense by the colony.

Several factors probably have contributed to the breakdown of territorialism for the pair. The first is that sexual fighting (fighting in reference to the sex-partner) is absent or extremely weak in the whole group. The situation may have permitted freer relations between the various members of the colony and a loosening of the sexual bond. A second factor which contributed to the breakdown of territorialism is the lack of a song. For most territorial birds song is one of the most effective methods of maintaining a territory and serves to indicate the boundaries of the plot of land and to threaten intruders. None of the communistic cuckoos has any note with the characteristics of song.

The weakening and eventual disappearance of the habit of active defense of a territory by a pair probably contributed to the development of social nesting in these cuckoos. Another influence of considerable importance may be the method of stimulation to lay eggs. Birds, like mammals, may be divided according to spontaneous or non-spontaneous manner of ovulation. In mammals the term spontaneous refers to species such as the rat which ovulate at regular intervals without external stimulation. Other species (non-spontaneous) such as the rabbit under natural conditions ovulate only after the stimulus of copulation. In birds the simple stimulation of coition has been superceded by the more intricate courtship performance. In many cases ovulation can be produced by a very slight external stimulus, such for example, as stroking the neck of female pigeons. There is considerable evidence that the communistic cuckoos belong to spontaneous type which requires no external stimulus to lay an egg. The birds

frequently drop eggs on the ground even far away from the nests and captive birds have dropped eggs promiscuously. The kinds of birds which ovulate spontaneously can dispense with courtship performance to stimulate egg-laying and since the function of courtship behavior is primarily, at least, the stimulation of ovulation, spontaneous ovulation and the lack of courtship are compatible. As a further correlative of spontaneous ovulation and the lack of courtship may be mentioned the lack of pair formation. Courtship, especially the mutual performances carried on during and after laying eggs, serves to bind the mates together and to prevent the dissolution of the pair. Thus in the communistic cuckoos the spontaneous method of ovulation made possible the disappearance of bonds between the members of the pair and the lack of bonds seems to have permitted communal nesting.

The development of social nesting in these cuckoos has depended largely upon influences closely connected with behavior and with the physiology of reproduction. The type of habitat is a factor of an entirely different kind which perhaps encouraged the evolution of communistic nesting habits but the importance of the habitat on the development of social nesting habits is difficult to assess. *Guira* inhabits areas of open parkland savanna and sleeps and nests in clumps of dense trees. Since there are few groups of trees in such vegetation, the birds tend to come together in flocks. The original habitat of *Guira* was probably the Chaco and the Campos of Brazil. These areas are characterized by open stretches of grass or marsh with scattered clumps of trees. The birds are able to feed out in the open but are forced to come together to sleep and nest. Although these islands of trees are sometimes very large, nevertheless there is the tendency for the birds to gather together. The members of the genus *Crotophaga* have retained the habit of feeding in open areas and sleeping and nesting in clumps of trees. These considerations suggest that the type of habitat in which the species originated forced the birds to come together in groups and to divide the territory into a nesting and a feeding habitat. The formation of flocks was conductive to the development of communistic nesting.

This group of birds has developed a unique type of nesting as shown by three developmental stages. The evolution of any anatomical or behavioristic character procedes in response to a multitude of conditions, none of which can be cited as the entire cause of the development. In the case of the phylogeny of the habit of nesting communally several factors may be considered as permitting the peculiar development. Perhaps the most important aspects are the breakdown of maintenance of territory, the habit of spontaneous ovulation, and the type of vegetation. The evolution appears to be guided by psychologic, physiologic, and ecologic influences.

A certain parallelism between the communistic cuckoos and humans may be noted in passing. One of the noteworthy differences between man and other mammals is the fact that human offspring remain with the parents for a very long time. Many of our social customs depend upon this intimate relationship. The communistic cuckoos also remain with the parents for a long time, in many cases for another breeding season. Indeed, the parents, the grandparents, and the young of another brood may join in feeding young birds in the nest. These birds have certainly developed social habits similar to ours and perhaps have even gone beyond.
—David E. Davis.

BOOK REVIEWS

A PACIFIC BAEDEKER

The Pacific Islands Handbook, 1944. R. W. Robson, F. R. G. S. 371 pp. Illus. 1945. $4.00. The Macmillan Co., New York.

FROM 1932 to 1942 the Pacific Islands Yearbook was published in Australia. War conditions prevented its publication in 1943 and the present edition, prepared by Mr. Robson of Sydney, Australia, has been issued in the United States. Much of the new material is American in origin and will prove to be of special interest to the people of this nation. The author presents a very careful chronology of the Pacific war from December, 1941 to March 30, 1944 and points out that each of the five groups of islands, Polynesian, Micronesian, Melanesian, Indonesian, and Non-Tropical, has been affected in one way or another by the activities pertaining to the great conflict. Near the opening of the book there appears a listing of the various island groups and a special listing of the islands governed by different nations.

Preceding the presentation of gazetteer data regarding each of the island groups Mr. Robson has given a brief but excellent summary of the history of the Pacific islands. There are thousands of these land areas in the Pacific Ocean and they range in size from New Guinea and Borneo, the largest islands in the world, to land areas that appear as tiny dots on our maps. When visited some of these very small islands are found to contain but a few acres of land. Many of the Pacific islands are the tops of lofty mountain ranges that lift their heads a few hundred up to a few thousand feet above the sea. These ranges rest on the sea floor three to four miles below the surface waves.

Most islands in the zone between the tropics of Cancer and Capricorn have coral reefs as festoons about their margins, or are composed entirely of coral limestone. Within this belt live unnumbered billions of tiny animals that secrete lime from the sea waters and build their skeletons of this material. They flourish in clear sea water all around the earth, where the depth is not more than 120 feet and where the temperatures do not drop below 68° Fahrenheit. Millions of coral skeletons broken into fragments or worn into sand grains by the action of waves are in each fringing or barrier reef; other millions are required to produce a single circular island enclosing a lagoon. Within the lagoons of these circular coral islands or atolls, the waters are comparatively shallow but with sufficient depth and extent to serve as safe harbors for ocean vessels and ships of the air. On page 41 you will find a carefully prepared description of a coral atoll.

The peoples who inhabit the Pacific Ocean islands vary greatly but they all presumably descended from early migrants from the Asiatic mainlands. They appear to be a mixture of Mongol, Caucasian, and Negro. There are hundreds of different languages used and since insular positions favored isolation the different groups of people have developed many customs and habits which are peculiar to themselves.

Until the middle of the 19th century these islands were not coveted by European or American nations. They were in a sense "no man's land." Today not a single one of them has not been taken over by some one of the powerful nations of the world. Each one is jealously held because of its strategic importance and the world awaits with considerable interest what may happen relative to the ownership and government of some of these islands following the close of the present World War.

The author is an able and a skillful journalist with an intimate knowledge of Far Eastern affairs. He has stressed many of the important events in the background of this war and laid a foundation for understanding some of the problems that must be faced after the fighting is over. He has known somewhat intimately of the activities of the Japanese people in the years preceding the war and has reviewed that history with skill and presented his ideas in a most readable form.

In the main body of the book the material is such as would be anticipated in a gazetteer or yearbook. There are articles about each of the important islands, and in each article the population, industries, shipping services and numerous other items of interest are treated briefly.

Mr. Robson has also included a section on political events in the Pacific. That is very welcome material for many who are becoming interested in the affairs of the Pacific Ocean peoples.

One of the outstanding features of this yearbook is an abundance of maps. Many of these are so large that they must be folded; others are small detailed maps of individual islands. The maps have been prepared chiefly for the purpose of bringing out the facts of location. Most of them do not reflect relief and they give no data regarding the climate, resources or other geographic factors of interest to many. Unfortunately on some of the maps, where an attempt has been made to show relief, as in the map of Polynesia, opposite Page 93, the cartographic work is very poor. The desire of the author to include so many maps is most commendable. It is unfortunate that he did not have more skillful draftsmen to help him in the preparation of that portion of his report.

Hundreds of thousands of American people have vivid recollections of experiences on and near these islands and in the homes of many of our countrymen, in the homes of Australians and New Zealanders there will be sad memories of the battles fought on or near these tiny land areas in the western Pacific. As a whole the volume is most welcome and especially at this time when all intelligent people of the world have become intensely interested in the Pacific Ocean area.

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A NEW APPROACH TO EVOLUTION

Tempo and Mode in Evolution. George Gaylord Simpson. 237 pp. Illus. 1944. $3.50. Columbia University Press, New York.

THIS volume is a notable contribution of the Columbia Biological Series to the newer knowledge of evolution, maintaining the same high level of originality, wealth of material integrated, and lucidity of presentation which characterized the two other books on the subject preceding it in the series. Dr. Simpson who is a paleontologist attempts to bridge the chasm which was thought to exist between the data and theories of paleontology and genetics. Students in paleontology were believed to deal in a descriptive manner with the course of evolution as deciphered from residues of the historic stream scattered about at random, while geneticists liked to depict themselves as peering into the inner mechanism of biologic change. There can be no question that the appearance of this book will help greatly eliminate the mutual distrust which insulated the two vital aspects of the same basic phenomenon.

This point is made clear in a brief introduction. The text of the book consists only of seven chapters each of which is loaded with valuable data and theoretical speculation so that hardly a paragraph fails to convey a new idea or present in a novel relationship previously known facts. In discussing rates of evolution the author correlates specific and measurable morphological features, such as dimensions of teeth, which are plotted against lapse of time or thickness of geologic strata for several genera of Equidae. From the resulting curve are deduced some very stimulating generalizations. Dr. Simpson also discusses such aspects as the comparative duration of life spans of genera, changes in their rates of evolution at different geologic states and presents a statistical treatment of survivorship of extinct genera. All are originally and penetratingly treated in a manner to expose new possibilities and relationships. The treatment has almost the flavor of magic in that the author does so much with relatively little paleontological material though it is spiced with a considerable mixture of genetic concepts.

In the discussion of the determinants of evolution such as variability, mutation rate, character, population size, length of generations and selection, all the available genetic data and speculations on the subject are marshalled and integrated. The author examines and expands the meaning of the terms micro-, macro- and mega-evolution as distinct phases of the evolutionary process. Comparative evolutionary rates of different lines are divided into types called horotelic, or possessing a characteristic frequency curve "with a strongly prominent mode and with frequencies of rates falling off steeply on each side, more steeply on the side of faster rates," bradytelic which display slower rates and finally tachytelic or faster ones. The

various features and fates of each type are discussed against the background of the recent contributions in mathematical genetics by Fisher, Wright, Haldane and others.

Particularly stimulating are the last three chapters entitled Inertia, Trends and Momentum, Organism and Environment and Modes of Evolution. The first two discuss such familiar problems as teleology and orthogenesis, pre- and post-adaptation, and the complexity of the relationship between environment and adaptive zones which leads to the somewhat intricate but suggestive concept of the adaptive grid. The last chapter presents brilliant and fascinating schemes of evolutionary courses and potentialities as exemplified in speciation, phyletic evolution and quantum evolution, the three main modes of the evolutionary flux. It is impossible to give any more detail of this powerful scientific stimulant. One thing is certain. Evolution is now a scientific discipline amenable to challenging analysis and sound speculation. With the help of the experimental labors which Dobzhansky, Wright and others have launched, explorable tracts will undoubtedly be brought to view in a field of investigation which many believed to be doomed to obscurity for a long period.

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PERSONAL NOTES OF T. JEFFERSON

Thomas Jefferson's Garden Book. Annotated by Edwin M. Betts. 704 pp. Illus. 1944. $5.00. The American Philosophical Society.

EDWIN MORRIS BETTS and the American Philosophical Society have brought to garden lovers many comfortable and satisfying moments in "Thomas Jefferson's Garden Book 1776–1824 With Relevant Extracts from his other Writings."

Just as Darwin's "Voyage of H.M.S. Beagle" has held both an honored and a useful place close by the hands of naturalists the world over, so this garden book may find a similar position with garden lovers. And just as the "Diary" of the voyage published in 1933 is in many ways more revealing and more interesting than the re-written "Voyage" published a century earlier, so "Thomas Jefferson's Garden Book" direct from the pen of the master himself is in many ways more revealing and more interesting than any re-telling of his garden activities by others, excellent though they may be.

The title "Thomas Jefferson's Garden Book" may appear at first a bit misleading, for the original Garden Book was a memorandum book 20.3 cm. by 16.2 cm. with 158 leaves, of which only 33 are filled with Jefferson's notes. These notes occupy only a few of the 704 pages of the printed book. In fact it is the "Relevant Extracts from his (Jefferson's) Other Writings" which comprise the bulk of the book and which are the best of the reading. They are taken from Jefferson's "Farm Book," "Weather Memorandum Book 1776–1820," account books, stray memoranda, and letters.

Here will be found the record of the years 1776 to 1824—begun when Jefferson was 23 years old and continuing into his 72nd year, the year that Lafayette visited him at Monticello. The entries show the broadness of his interests—the date the first purple hyacinth bloomed in the spring, when peas were up, when the blossoms and pods were formed, when the peas were ready for the table. He noted that it took 100 strawberries to fill a half pint, to which Professor Betts adds the valuable comment that today "15 strawberries fill one half-pint." He found tongue-grafting a very effective method of top-working fruit trees and claimed to experience losses of only five grafts in a thousand.

On March 31, 1791, he wrote to his daughter, Maria Jefferson, in Philadelphia, "I wrote you in my last that the frogs had begun their songs on the 7th; since that, the blue-birds saluted us on the 17th; the weeping-willow began to leaf on the 18th; the lilac and gooseberry on the 25th, and golden willow on the 26th. I enclose for your sister three kinds of flowering beans, very beautiful and very rare. She must plant and nourish them with her own hand this year in order to save enough seeds for herself and me." And so the story runs from page to page of most delightful reading.

Professor Betts' annotations are helpful. Many more could undoubtedly have been made had space permitted. The "plumb-peach" mentioned by Jefferson several times and which Dr. Betts has not found listed in pomological works is very likely the nec-

tarine. The same expression is even today used colloquially for the nectarine. In 1807, correspondence from Timothy Matlock of Lancaster mentions the "Moor Park Apricot," which is still grown today as "Moorpark," and the same letter describes "Sechell's Pear." If this is the "Seckel" variety, which originated near Philadelphia and which, too, is still grown and esteemed today, it is as early a reference to this variety as can be found in pomological literature. In 1811, Jefferson wrote to Madame de Tessé in France, thanking her for the seeds of Koelreuteria, "one of which has germinated and is now growing. I cherish it with particular attentions, as it daily reminds me of the friendship with which you have honored me." The Koelreuteria is today an interesting and too-little known ornamental plant.

Everyone who peruses this book, for it is not a book to be read at a sitting, will find passages that appeal to him especially. For example, "The greatest service which can be rendered any country is, to add a useful plant to its culture; expecially, a bread grain; next in value is oil." Again, in a letter to Dr. John Manners, written February 22, 1814, is a remarkable statement regarding classification of plants and animals —"Nature has, in truth, produced units only through all her works. Classes, orders, genera, species, are not of her work. Her work is of individuals. No two animals are exactly alike; no two plants, nor even two leaves or blades of grass; no two crystallizations. . . . This infinitude of units or individuals being far beyond the capacity of our memory, we are obliged, in aid of that, to distribute them into masses, throwing into each of these all the individuals which have a certain degree of resemblance; to subdivide these again into smaller groups, according to certain points of dissimilitude observable in them, and so on until we have formed what we call a system of classes, orders, genera and species. In doing this, we fix arbitrarily on such characteristic resemblances and differences as seem to us most prominent and invariable in the several subjects, and most likely to take a strong hold in our memories. Thus Ray formed one classification on such lines of division as struck him most favorably; Klein adopted another; Brisson a third; and other naturalists other designations, till Linnaeus appeared. Fortunately for science, he conceived in the three kingdoms of nature, modes of classification which obtained the approbation of the learned of all nations. His system was accordingly adopted by all, and united all in a general language."

"I adhere to the Linnaean because it is sufficient as a groundwork, admits of supplementary insertions as new productions are discovered, and mainly because it has got into so general use that it will not be easy to displace it, and still less to find another which shall have the same singular fortune of obtaining the general consent. During the attempt we shall become unintelligible to one another, and science will be really retarded by efforts to advance it made by its most favorite sons. I am not myself apt to be alarmed at innovations recommended by reason. . . . My reluctance is to give up an universal language of which we are in possession, without an assurance of general consent to receive another. And the higher the character of the authors recommending it, and the more excellent that they offer, the greater the danger of producing schism."

Through the pages walk the great of his generation—George Washington, Thaddeus Kosciusko, Patrick Henry, Andrew Jackson, the Marquis de Lafayette, and James Madison. The correspondence brings to life Andre Michaux, Bernard McMahon, Rafinesque, John Bartram, David Hosack, Baron von Humboldt, and Lamarck. He ordered fruit trees from William Prince, of America's first family of nurserymen; and he corresponded with John Adlum, the father of grape culture in eastern America.

Professor Betts has done especially well in presenting the political background year by year as the chronicle of the "Garden Book" is revealed. So much of history treats solely of wars and battles and political crises. It is refreshing to find a place where the leading personalities of Jefferson's day are entwined with gardens, plants, and intensely human qualities.

The book is well printed and fully indexed. In addition to the 685 pages dealing with the Garden Book and relevant extracts from Jefferson's other writings, it contains 45

pages of appendices of interest, including a description of Jefferson's "Mouldboard of Least Resistance" and a list of books and pamphlets on agriculture, gardening, and botany in his library. The binding is adequate, but one wishes that circumstances might have permitted a more elaborate handling, to which the contents are well entitled.

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A PHYSICIAN'S CREDO

The Doctor's Job. Carl Binger, M.D. 243 pp. 1945. $3.00. W. W. Norton & Co., New York.

This extraordinary book defies the reviewer. The excellent diction is intriguing, interspersed with wit, some satire, compelling laughter when one is so stirred up he does not feel like laughing.

Chapters on the changes in medicine, specialists, choice of a physician, doctors and patients, are familiar to all doctors and are replete with valuable information for the layman. The chapter on psychoanalysis is confusing more or less to doctor and layman alike.

It is the chapter on Psychiatry and Medicine that is of particular interest today. The whole world now is the problem for these specialists. No Bacon today can write it all. From the Inquisition to the Thirty Years War to Hitler, is one and of the same pattern. How the world became as it is history tells. "In medicine's struggle with superstition, magic gives way to religion and religion to the method of science" says the author. That the truth will make us free has been prated throughout the centuries ignoring the fact that truth has been ignored while babbling superstition and religion. Why it remains so despite the development of great minds in science and mechanics is the major problem today.

The chapter on Some Common Psychiatric Problems as the author states "bears the problem of personal guidance" but also the guidance of nations in this world of turmoil. Perhaps he comes to the kernel of things when he states "Few of the clergy can manage human maladjustments which tax the most experienced psychiatrist." That I would say is the real kernel of the book. What we need is knowledge and not a play of words on things that never existed. Thinking without facts makes possible the proof of things one wants to see. Like hope of peace by prayer, when it is obvious that as an intermediary stage we must have cannon and airplanes. Experience has forced this upon the attention of everyone, even those it would seem who prefer to bask in the penumbra of a promised salvation.

It is only by tackling the psychiatric problems as the author does can we hope for a diagnosis and prevention of states such as now engulf us. He presents an interesting discussion of all the little wars that beset society varying all the way from child tantrums, puppy love to domestic turmoil and divorce which is the prototype of war. In both, mercy and truth must both go behind the ropes.

The new freedom has received a warning that the old restrictions are struggling with the new freedom. This he expresses "Man has not only taken a bite out of the apple but has swallowed the whole business with a resulting colic."

These revealing chapters while applied largely to individual problems are applicable to the solution of the diseases of the world. Herein lies the great stimulus to be found in the book now that we all are fearfully speculating on whether or not our so-called civilization has finally succeeded in committing suicide. It is a message of hope in the midst of despair.

Other chapters have more to do with the simpler problems of disease. Socialized medicine now excites the apprehension of many in the profession because they believe it threatens the science and practice of medicine which has developed within itself. The author presents this so comprehensively that it removes this fear. We must realize that we are facing new factors. All realize that the field of medicine has become so broad that some sort of group effort is mandatory. By showing that a large part of medicine's efforts are already socialized the author makes the prospect of the next step more palatable. This fact comes as a sort of revelation to those of the profession who grew up with the changes quite unaware that they were taking place. The confusion caused when one group does the planning while

another compensates, the violinist is now apparent. The small boy who hits the hornets nest plans something but it goes beyond the planning. Thus it comes about that active peristalsis is mistaken for mental activity. Sensations which should call for the bed pan are interpreted as an urge to sing.

It is a pity that this book cannot be used as the basis of a course of study, not only for premedical students but for the average students of college. It would give a broad view of life and living important to the individual and through individuals to a better comprehension of world problems. It would make the student understand the basis of a nobler life, and what is more, to want it. Yea, verily the truth will make us free but the juggling of it as we see now may raise something, the terribleness of it surpassing the headaches of Dante and Milton.

The truth will make us free but when do we start courting it? Here is a starting point not only for the layman but for the medical profession.

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PENICILLIN IN PERSPECTIVE

The Story of Penicillin. Boris Sokoloff, M.D. 167 pp. 1945. $2.00. Ziff-Davis Publishing Company, Chicago.

IN this small volume the author ably combines an entertaining style with extensive information to bring the reader the high points of one of the most interesting stories in all science. The book is highly recommended to the intelligent lay reader who will appreciate the use of nontechnical terms wherever possible. The physician, the biologist, and other scientists will also enjoy this well-documented portrayal of science at its best. Extensive footnotes combined at the end of the book supply details for those desiring more complete information without interrupting the telling of the main story.

The first chapter provides an interesting setting based largely on personalities and experiments at the Pasteur Institute in Paris to orient the reader and acquaint him with the problem at hand. The monumental discovery of penicillin by Dr. Fleming is obscured somewhat in the second chapter by the author's enthusiasm in giving all due credit to Dr. Florey for bringing the great discovery to the attention of the medical profession. One might wish for a better look at the human side of Fleming, the man, as well as a fuller coverage of the rebuffs he encountered in attempting to interest the world in what he had done. No mention is made of his having been knighted for his contribution. Chapter three surveys the problems encountered in converting Dr. Fleming's laboratory experiments into the massive manufacturing enterprise necessary to make the new drug generally available. Why the English scientists entrusted this venture to their American allies and the contributions of the latter to the practical aspects of the problem is well covered. The triumphs of penicillin in each of the important diseases amenable to it are illustrated in the fourth chapter. One might wish the limitations of penicillin had been stressed more to avoid leaving the non-medical reader with the impression that the drug is a panacea. Chapter five mingles medicaments from molds in folklore with the present feverish activity to obtain useful drugs other than penicillin from molds. In the last chapter Dr. Sokoloff very ably depicts the problems, aspirations and rewards of workers in the fields of medical research. At many points in the book one encounters undue emphasis on nationalism. Science, like music, transcends geographic and racial boundaries.

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COMMENTS AND CRITICISMS

Dear 'Fessor:

A note to let you know that I am still alive and well after last week's excitement—and to thank you for the reading material which you have sent me. THE SCIENTIFIC MONTHLY I enjoy especially. I note especially one article in last December's issue, describing an imaginary visit of A. A. Michelson to Immanuel Kant, which you read and commented upon, and which I cannot forbear to write you about.

As you probably remember, what the whole article resolved itself into was a critique of the basic premises of the scientific method, in which this method came out somewhat second best at the hands of Philosophy. Judging from the points you marked, I would say that you seemed rather taken by the philosophic viewpoint yourself, and that is what leads me to bring you to task. I take a dim view of Philosophy in general, as I have probably told you. Nearly all of its systems, from the days of Plato to those of Spencer, when viewed objectively appear as nothing more than rationalizations of the prevailing moral values and metaphysical cosmology of the time in the light of the knowledge then available. You can see St. Augustine in the dark ages perfectly content with the theological views of the times, and everyone from Descartes to Hegel trying to "resolve the opposites" brought on by the new found knowledge in its impact upon beliefs which had been believed to have a divine, or at least an intrinsically valuable, origin. Your article is still carrying on the old game of trying to rope in science and break it to the philosophic halter.

Now it seems to me that the only philosophic school which ever brought to light anything of lasting value was the English "school" which began with Locke and ended with Hume, with old Bishop Berkeley sitting very uncomfortably in the middle. As your author pointed out himself, these men put a tack in the chair of philosophy which has caused its occupants to rest very uneasily ever since. Locke made the initial observation that we can know the external world only by our senses; the Bishop shrewdly pointed out that, since these senses are fallible, we cannot really be sure that the external world exists at all; and then Hume proceeded to hang the Bishop by his own cravat by failing to find any ground for the existence of the Almighty. It seems to me that no philosopher since has ever been able to find his way out of this impasse. With all due respect to Kant and his kindly views, he sounds very unconvincing.

Since that time, various other men, not philosophers at all, have even further strengthened the position of Hume. Not just the senses, but the human mind itself has been shown to be very, very fallible. The accumulated data of zoology reveal the brain as an adaptive mechanism, which adjusts the human to his environment. Psychology and physiology show the mind to be nothing but the manifestation of the working of the brain, much as the moving picture on the screen is manifestation of the working of the picture machine, and in no way independent of it; and they show too that the picture varies according to whether the machine has a high or low blood sugar, an excess of adrenal secretion, or a hyperactive thyroid. On top of all this, Freud, one of the truly great contributors of all time, showed that this mind can be shown by scientific observation *not* to be under the voluntary control of its possessor at all times; its thoughts can only be developed in those patterns determined for it by its hereditary capacity to think as developed and altered by past experience and present bodily well being. The synthesis of all of this is this: the human mind is not a reasoning mechanism at all, but the manifestation of a brain which is geared to produce THAT ANSWER WHICH IS MOST COMFORTABLE TO ITS OWNER, AND TO MAKE HIM BELIEVE THAT THIS ANSWER IS THE TRUTH. In the light of this knowledge we can see how it is that men—even the most learned and wise—cling so dearly to so many versions of the truth, and mankind advances by slow fits and starts; and we can see that the probability of man's reaching the truth by a process of "pure reason," without checking their results at every step by experiment, is quite remote, even in the case of a Kant. (Who, by the way, was a very neurotic individual.)

Now what of your philosophic method? I admit to you that we cannot know of the existence of the external world, or of the Almighty. Let me go farther, and point out that those men who try to do so by introspection give the impression of so many cows, contemplating their own bovinity. I agree that I can find no justification for my method within my own mind—but pragmatically (John Dewey is very useful) I must say that it makes no difference whether the external world exists or is just an idea. If we *assume* that it exists, and start from there, we seem to be able to alter the conditions of our existence vastly for the better by using the scientific method. And since this assumption has seemed to work, and been so fruitful, those of us who stand upon it cannot help but be amused at those philosophers who have started with another ASSUMPTION—that "I can reason"—and have lead themselves thence into a maze of sterile contradictions.

And so, 'Fessor, I don't find myself fazed by philosophers as so many men do. The typical old

philosophical argument that "we cannot conceive of such a situation," and therefore it cannot exist, or must be untrue, produces nothing from me but a horselaugh. Imagine Plato trying to conceive of radio, or Kant working out the present concept of the quantum, which is now a wave, and now a particle. Such an argument has no bearing upon the facts of the case; it is merely a commentary upon the limitations of the human mind.

The successful philosophers are the schizophrenics, who build their own mental world and retreat happily into it, while the rest of us hard-working individuals feed and shelter them.—(Lt. LAWRENCE E. HINKLE, JR., M.D., USNR)

Letter dated March 22, 1945 from a young naval officer to his father.—ED.

Proselyte or Temporize?

It is time that scientists, individually and as a group, should assert themselves. Not that they should organize as a pressure group for their own aggrandizement as some suggest, but that they should get at the job of performing the service to their country which they alone can do.

Scientists are now busy in laboratories throughout the country at the task of winning the war. They are hard working men, modest for the most part, and content with the satisfaction of knowing they have done their work well. Unfortunately, they are so modest that they are quite inarticulate outside their own profession. While officials in government, labor, and management virtually monopolize the public stage, the men who even made that stage possible remain in the background. Fortunately, public recognition of the role of scientists in winning the war is slowly emerging. This is as it should be, but it is not enough.

Equally as great responsibilities and opportunities lie ahead. Summed up, they can be stated in one sentence: Science is the major hope for creating the jobs which our people will need after the war.

Scientists are aware of this. They write papers on the subject for each other to read; they make speeches about it for each other to hear, and there is no essential argument. Naturally, they know that the problem is not so simple. Science alone cannot do it. Scientists need the support of private industry and of government for the facilities and the opportunity to work. They must have the support of these same groups to produce the results of their research in quantity. They must have the support of the distributing and servicing organizations which take these products to the public and enable the public to use them. They must have the support of the public itself. All are members of the team, but the scientists must create the products upon which all the others depend. Scientists must provide the ball for the rest of the team to carry.

All this seems clear and straightforward to the scientists. But is this enough? What do the people think who will benefit from the manufacture, sale, and consumption of these products? What do the managers of business think? What do the officials of government think?

To most laymen, science is still a mysterious and even awful thing. As for scientists, the cartoon caricatures of them as bearded, desiccated savants who ply their profession among nightmares of glass-blowing and behind locked doors is surprisingly close to being correct. True, the public reads accounts in the press of great discoveries and inventions, but too often these are "souped up" so that they bring a blush to the scientists involved. There is much to be read about tomorrow's dream world full of gadgets and leisure. But in these accounts there are many overstatements which, while sincerely meant, are damaging to the outlook of both the scientists and the public. How much better if the public could look upon scientists as individuals who practice no magic, and whose "miracles" are born and reared only by long and arduous hours of work? Scientists must tear away this veil of mystery and let the public see them as fellow humans.

In recent years, the managers of business have begun to learn the power of science when it is applied to their own problems, but their conversion is far from complete. Even in the chemical industry, there are islands of management holding out against the scientists with the defense that scientists are luxuries or necessary evils which are to be discarded when business declines, i.e., just when they are needed most. Among industries where the relation between science and business is not so obvious, there are still many converts to be made among the members of management.

In fairness it must be admitted that this is not altogether the fault of the managers. At least half lies with the scientists who for one reason or another are inept at meeting on common ground with businessmen. It is high time, therefore, that scientists meet them more than half way and demonstrate to them that in the diversified fruits of the laboratory lie the industries and the jobs of the future.

It is among certain officials of government, particularly the economists, that scientists have fared the worst with respect to the postwar period. Last year a contest on the subject of providing postwar employment was sponsored by a nationally known company whose very existence depends on certain fundamental natural processes. Most of the winners of this contest were government officials whose duties, directly or indirectly, were concerned with planning for the postwar period. In only two of all the winning plans was there more than passing reference to

the use of science to create employment. In many of the plans it was implied that no more applications of science which would result in major economic growth could be expected. Rather, most of these planners would provide employment after the war by changes in and controls of our economic system.

Now scientists will welcome corrections of the system which will permit it to function more efficiently and thereby better serve the needs of the people. They also will be, or should be, content to leave such corrections to those who are experts in those matters. But the creation of an optimum environment will only allow the economic system the freedom to function. The environment itself cannot create. The scientists must create the technological food on which the economic system survives and grows in the optimum environment.

Fortunately, among other officials of government there are indications that plans are under consideration to help harness science to industry in a manner similar to that which harnessed science to agriculture. This is a step forward, and if properly conceived and administered, it should be beneficial. Government has recognized the importance and power of science in winning the war and in preserving national security after the war. Scientists must see to it that government recognizes the importance and power of science in our economic life after the war.

To proselyte is not in the nature of most scientists, but the fact remains that science is the great hope for the future. This is the golden opportunity for scientists to convince our people that the application of science can create jobs and prosperity and happiness. Is there any higher justification for knowledge than the benefaction of mankind.—S. D. KOONCE.

Malthus Rides Again

In his review of my book, *Enough And To Spare*, under the heading "Population Problems" (SCIENTIFIC MONTHLY, vol. 60, pp. 316–317, April, 1945) Professor Karl Sax disagrees sharply with my conclusion that the available resources of the earth are adequate to meet all the future needs of mankind. Two items seem especially to have aroused his indignation to such an extent that his comments display more of partisan bias than of unprejudiced appraisal.

The fifth paragraph of his review opens with this sentence: "The declining birth rates of the Western nations are attributed by Mather to the natural consequences of man's evolution and 'are due as much to physical factors of the human body as to the mental attitudes toward the bearing and rearing of children.'" What I actually wrote is as follows (*Enough And To Spare*, p. 47): "Artificial stimulation of population growth by governmental decrees, economic measures or political propaganda has had such meager results wherever tried that it is unlikely ever to be significantly effective in any country. Indeed there is some evidence, though inconclusive as yet, that declining birth rates are due as much to physical factors . . . etc." By quoting only a part of a sentence, Professor Sax makes it appear that I was guilty of making a dogmatic assertion about matters concerning which present knowledge is obviously inadequate to justify any positive conclusion. As Enid Charles states in her book, *The Twilight of Parenthood*, page 185, "we know far too little of the physiology and psychology of reproduction to dogmatize about their relative importance." Thus, Professor Sax prepares the way for his caustic comment: "One wonders where Mather obtained his biological information regarding the causes of the decline in human birth rates."

As a matter of fact, there is no excuse for that sort of wonderment. The bibliographic references pertaining to this portion of my book appear in full on page 176 and begin with one of the standard treatises on the subject, Raymond Pearl's *The Natural History of Population*, London, 1939. Pearl's analysis of population data bears out his assertion, page 256, that "the decline of fertility . . . appears not to be exclusively confined to highly 'civilized' countries, where the populations are most sophisticated and eager and adept at birth-controlling. It seems rather to be a world-embracing phenomenon—something affecting man as a species."

The other item to which Professor Sax objects is my survey of the potential agricultural resources of the world. Here he conceals the fact that I specifically attributed the estimates that I used to such authorities in this field as H. L. Shantz of the U. S. Department of Agriculture and F. E. Bear of the New Jersey Agricultural Experiment Station. He would have been fairer to all concerned had he modified the first sentence of his fourth paragraph to read: "Mather used estimates of potential agricultural production made by experts whose conclusions I consider to be unrealistic if not fantastic." It is not that I want to hide behind the skirts (or trousers) of other people. The point is that Professor Sax gives the impression that I, a geologist, have barged into an area in which I am quite incompetent to pose as an authority and have announced conclusions without adequate investigation of the facts. To protect the data against any such personal handicap, I took especial care to indicate the sources from which they were derived, but the review is so worded as to conceal that aspect of the case. As a matter of fact, if Professor Sax really meant what he wrote in his review—"We can have a permanent and *increasingly productive* agriculture" (italics mine)—he is at least as optimistic as I am.

The leading editorial in *Mining and Metallurgy* (the official journal of the American Institute of Mining and Metallurgical Engineers) for April 1945

closes with this sentence: "Those who worry about the exhaustion of minerals are either uninformed or they underrate the ingenuity and resourcefulness of the researcher and the engineer." May it not be equally true that those who worry about the inadequacy of food resources to meet the needs of mankind are either uninformed or they underrate the ingenuity and resourcefulness of the soil conservationist and the bio-agronomist?—KIRTLEY F. MATHER.

THE BROWNSTONE TOWER

At last the manuscript is finished. Written during the heat of inspiration, it was laid aside to cool; then it was taken up again and polished with loving care. Now it seems ready to go to the Brownstone Tower.

With parental solicitude the author mails the offspring of his mind. He worries until he is notified of its safe arrival and remains uneasy until word comes that it has been accepted for publication in the SM. After a brief glow of satisfaction his attention turns to other matters, and the manuscript is forgotten—temporarily. Then one day it flashes back into his mind: Why has not galley proof been received? Has the manuscript been overlooked or mislaid or lost?

The alarmed author should be reassured by the following explanation: Unlike many technical periodicals, the SM cannot publish manuscripts strictly in the order of their receipt. The waiting period of any manuscript is determined not only by the total number on hand but by the number in each field of science; usual practice is to publish only one article per issue in a given field. Most manuscripts are published within four or five months after receipt. Occasionally, a timely manuscript is rushed into the next issue. Thus Miller's article on the port of Cleveland was expedited to bring it out before the Cleveland meetings, and Harris' article on the Ruhr was pushed ahead so that it would appear before our troops occupied that center of heavy industry. At the other extreme, a manuscript may have to await publication for almost a year if it is, let us say, one of nine accepted articles in zoology and requires considerable editing. The significance of the last sentence should not be overlooked. Except for timeliness, nothing is more likely to expedite the publication of a manuscript than its submission in good form. The easier it is to edit a manuscript, the sooner may follow all other operations.

The number of manuscripts on hand at any time must be greater than the number of articles (eight to ten) published each month. In order to assure continuous operation of the SM and to facilitate its make-up, it has been found desirable to maintain a stock of about thirty-six manuscripts.

It is not difficult to make up an issue if many articles are in galley proof. An issue is built up around certain articles that are chosen because they are timely or because their turn has come. The other articles are selected from the stockpile to complete a diversified table of contents.

The time that elapses from the receipt of an acceptable manuscript until its galley proof goes to the printer as part of the make-up of an issue is variable and unpredictable, but the period from make-up to distribution of the issue by the printer is fixed, if all goes well, at three weeks.

Without reference to time, a manuscript goes through the mill as follows: The editor receives, records, accepts, and files the manuscript. When he edits it, he may, if necessary, correspond with the author. When satisfied with the manuscript he sends it to the printer, who returns four copies of corrected galley proof and proof of illustrations, if any. One copy of galley proof is read, corrected, and approved by the author; another by the editor. Corrected and approved copy is filed for use in make-up. The chosen galley proofs are paged, and dummy is made for illustrated articles. From this material the printer prepares and corrects page proof and sends two copies to the editor, who reads and corrects them and returns one copy to the printer. The printer makes final corrections in the type and prints about 14,000 copies of the issue. When it is mailed on the twenty-fourth of the month, a small supply of copies is sent to the office of the A.A.A.S., from which one copy is mailed to each of the authors of principal articles.

After publication of an issue its manuscripts and all material pertaining to them are held two months for reference lest any questions should arise. At the end of that period manuscripts and proofs are destroyed, the correspondence is filed, and illustrations are destroyed unless the author has requested their return.—F. L. CAMPBELL.

THE SCIENTIFIC MONTHLY

AUGUST, 1945

THE FALLACY OF THE "LOST YEAR"

By A. G. KELLER

EMERITUS PROFESSOR OF THE SCIENCE OF SOCIETY, YALE UNIVERSITY

PROMINENT among legislative agenda is "a national, compulsory, peacetime service bill for all American youth." In not being designated as "military," it avoids a challenge to one American allergy; but it runs head-on into another by reason of the adjective "compulsory" which, to not a few, envisages the policeman, just as "military" has, by tradition, connoted the top-sergeant. Perhaps a more formal term, such as "statutory," might arouse less instant antagonism.

The essence of the matter is simple enough: the civic duty of national defense legalized for all American youth, instead of being left to individual conscience; and training for the discharge of that duty provided under the direction of those responsible for national defense. That such training is to be "military" in its prime objective is inevitable.

There was a time, as witnessed by the top-sergeant tradition, when military training was both narrow and harsh. It still is, in a number of countries. It is not so here. Anyone who has followed the adjustments at West Point and the careers of West Pointers, in civil as well as in military life, knows full well that the Academy has been no "breaker of spirit" but a builder and strengthener of body, mind, and character. There are many of us who, though no longer young twenty-eight years ago, entered the Army as civilian officers in World War I, to obey orders where we were accustomed to give them, and to sustain occasional snubbings; and have regarded even our few months' awkward service as a life-asset.

It is a fact that prolonged service in wartime has upset some young men so that they have chafed at the comparatively flat and unadventurous quality of civil life; but that objection is irrelevant to the question of a short, not narrowly military, peacetime training. I, for one, can discover no valid arguments against this requirement of national service. If two terrible object lessons within a few years have not taught democracies the need of national preparedness against predacious peoples who openly despise us as soft, effete, providentially designated victims, then we deserve what is coming to us—eventually, if not now. As for the individual, privileged or unprivileged, that he will be better off physically is not debatable. And there is no idea of letting his mind or his character go to seed.

It is not only that his physical defects are going to be detected and rectified, his diet balanced, his intoxicants limited, and his exercise adapted so that if he has been living too high, fast, and soft, or too low, slow, and hard, he will be stressed toward some mean that is better for him; it is also that his mental and moral hygiene will be improved. He is going to get some genuine and highly practical education.

He is going to be "toughened" in mental and moral fiber. But toughening is by no means synonymous with "brutalizing." Nobody in this country wants to emulate the spirit of the Hitler Youth curriculum. Quite the reverse, for one of our main objectives is the banishment of that spirit into limbo and its imprisonment there. There will be as little instruction in "hatred" as there is in a fencing academy or on a baseball field. The governing idea is to impart techniques in the use of head, hand, and heart that are applicable in social life as a whole, not on the battlefield alone.

The inclusive mental and moral benefit from the kind of training proposed is the intelligent acceptance of discipline—of which more presently. Consider the effect on morality exerted by assembling youthful delinquents and making them behave themselves for a year or so, in the meantime opening to their vision careers alternative to their antisocial drift—alternative courses, of which they have not caught sight at all.

Evidently this moral-angle slant heads toward education. It would conduct many of the underprivileged and misled, whether or not they like it, into the reach of the learning—and the unlearning—process. In fact, all the approaches to this national service issue lead to education as do spokes to a hub; so that the hub offers a strategic point for viewing the whole wheel.

It is no accident that "discipline" derives from the Latin *disciplina*, meaning "learning." Education is nothing if not disciplinary. The School-Teacher of all time has been Experience, generally Sad Experience; and if experience is not disciplinary, nothing is. So, for the rest of this survey, we take a position on the aforesaid hub.

Education, in the abstract, has the reputation in America of a miracle-working fetish, to which all bow down "in wonder, love, and praise." But when one gets near enough to the idol to see it in the concrete, not only its feet but other items of its structure strike him as anything but godlike. Any veteran teacher can hark back to hours of shrill, censorious buzzing at education, in solo or in chorus, in youthful falsetto or in parental treble and bass, that seem in retrospect to have been as unremitting as cricket-stridulations of a summer evening. Practically every item in any and every educational set-up has been damned, at one time or another, and not alone with faint praise. Though the main tune has been: "Education, our Safety in all Generations," there have not been lacking, when it came to the concrete program, dissonant variations or qualifications.

The first practical question that confronts one who ponders over the alleged "lost year" is this: "Is essential education going to be sacrificed by instituting national service?" If the education that is to be interrupted for a year or so is something altogether perfect, and as such irreplaceable, then it would be imbecile to sacrifice even five minutes of it. But not even the professional educationalist believes in that perfection except for his own version; he is, on the contrary, the most impatient and fanatical of reformers, inveighing against what is, sneering at it as old and shopworn, and proposing radical alterations and replacements. He calls loudly for the fetish-worship of Education; but inference from the rites which he prescribes in the endeavor to attain concreteness makes the fetish look as multiform as Homer's Proteus, and as shifty—Lo, here! Lo, there!

The contention here—to be brief and blunt—is that a year or so of such education as we purvey in schools of various sorts could be spared without shattering loss. College men whom I have known, with few exceptions and from a number of colleges, have repeatedly stated that such and such parts of their four years have amounted to a "total loss." They have singled out a few courses as "the only ones that taught us anything worth while." More frequently they have cited their "dead losses" and "hopeless boredoms." Over and over, they have referred to their athletic coaches, who "stood for no nonsense," as their best teachers. Such expressions are not confined to undergraduates. Many an elderly alumnus has reaffirmed them, years after, together with the hope "that things are better now."

Parenthetically, there is the apparently contradictory case of, say, the premedical collegian who realizes the indispensability of all his preparatory courses, but is uneasy because he feels that he has not been really educated. One engineer, with a similarly specialized course, put it this way: "Why don't we get something human? We all smell of gasoline." And he went on to say that there had been enough waste stretches in his earlier education that might have been planted with what he now missed—in fact, that he would be glad to have had his present course extended a year to supply that lack. Though such preprofessional cases are comparatively few among the millions to be called to service, they serve to fill out the picture.

As for the ordinary college course, how

many graduates could be found who could not, in retrospect, spare fifteen out of those sixty or so hours without a sense of irreparable loss? Many a graduate has expressed the opinion that whatever he had acquired in college—except for the imponderable advantage of spending an extra year in its characteristic "atmosphere," an advantage rather irrelevant to the topic before us—could readily have been accumulated in three years or less.

College men constitute but a small and privileged portion of those eligible for national service. Consider now the high-school contingent. Some of us found, in actual experience, that it was no great matter, fifty years ago, to skip a year in a first-class institution. It took considerable anxious effort and vetoed vacations; but we have felt no sense of educational loss. It is true that we could not have spared the extra year that we were skipping; but even for the less hurried student, those four years could have been condensed into three without any substantial sacrifice, by omissions of the valueless or less valuable, and by better teaching.

It is not impossible, either, that a year might be similarly saved in the grade-schools; and I do not mean through the adoption of any touted foreign system. It has been proclaimed, over and over, that English, German, or French pupils are better educated than American students two or three years older. I have never believed that. I once heard an eminent Russian scholar, on being congratulated because he had learned so much at so tender an age, reply: "But I had no youth! I had no youth!" And I have pitied every John Stuart Mill. The ability to compose Latin verse, or to read Gaius in the original, remaining the while pathetically lopsided and self-complacent about it, has never struck me as a superiority. I have heard intelligent foreigners bewail the narrowness of their traditional education and remark that it would take a number of first class funerals to get rid of it. As one eminent college dean used to put it, real education is not a drill-hole, very deep, very narrow, and very dark down below; it is an excavation, into which the light of day can pour.

There is a lot of fluff in lower-school curricula, from the kindergarden up, that has been interpolated by exponents of the bright idea and "taught" by hypnotized and muddled teachers. A full year's work, or more, on infant philosophy and opinion-swapping of one kind or another—of "teaching to think" where the wish is father to the thought—could be cancelled with no loss whatever except that of intellectual ragtag and bobtail.

In short, a year or so could be saved almost anywhere along the line, without losing anything vital to education; and at the same time a wholesome pressure could be exerted to make the remaining years amount to more. General education would profit. So long as any study has a kind of protective-tariff wall around it, in the shape of a don't-touch-me tradition, to shield it from competition in the open, it will squat where it is. The teaching of the classics has gone to seed behind such wind-breaks, and so has that of modern language, in adhering to the same ineffective methods. What is the use of "taking" Latin or Greek for years on end, if you never learn to read it? It is lucky for the modern languages that practical utility, demanded in a crisis-time, has forced, largely at the instance of the Army and Navy, common sense toward the front. For common sense, long in abeyance, refuses to credit the ancient contention that one can "appreciate" what is said or written in a foreign language when he doesn't know what the words mean. I well recall the ecstasies of a certain aesthete over a passage in *Faust*. Being asked to translate, he couldn't. What he had got out of the passage was a seductive noise.

There would be no object in rescuing a year, even out of chaos, if there were nothing to do with it, or only something worse than nothing. Teaching "brutality" would be worse than nothing—even worse than the most fatuous offerings of any current curriculum. But brutality is out, as remarked heretofore. What is "in"? What will service-education teach?

Assuming that theorists, pedagogical or bureaucratic, do not get hold of it, the proposed service education, whatever its specific content, will be practical, and along lines indicated toward the outset of this survey.

Moreover, though one must await any publication of schedules, he can be confident that two vitally essential desirables will be inculcated, directly or indirectly, in all curricula: Discipline and "Democracy."

Education in this country, by life-experience or in schools, has been weakening in the element of discipline. All the shouting has been for liberty and rights, with little heard about discipline and duty. The covering case of liberty *versus* discipline cannot be presented here; but it can be stated flatly that discipline is quite as indispensable to individual and civic well-being as is liberty.

Discipline is not popular, because it means restraint and compulsion: to refrain from doing what one wants to do, and to do what one does not want to do. And real education involves both of these unattractive performances. One may not choose to go as far as the Seer of Archey Road, who remarks that it makes small difference what a boy studies, so long as he doesn't like it; nevertheless there is sense behind that apothegm. As it is not by sauntering nonchalantly along the easy way, or floating with the current, that muscular fiber is strengthened, no more is character-fiber won by dodging the unpleasant or even the repulsive duty. Obedience to duty is a primary lesson in discipline —a lesson set by some form of authority. To learn it is not demeaning at all, but a display of intelligent discretion.

The proper order in education, especially at the outset of schooling in general or in particular, is: obedience first, reasoning second. That has been the order which the race has had to follow if it was to survive. It is the order of learning anything. Until we have been through the mill we are incompetent to judge of it, favorably or otherwise. Men have obeyed "Natural Law" for ages before they have understood it in the least. We have become "reconciled with the Universe" because "we'd better be." With all our "progress," we understand very little, even yet. Furthermore, the more we do understand, the more there is to try to understand, so that we have very small prospect of full understanding, ever. But obedience must go on, irrespective. The Way of Things cannot be challenged.

How Natural Law works has been discovered by long experience and the necessity of obedience to it. Men have always been concerned about how best to identify and obey it, that it to say, to apprehend, and then to adjust to, life-conditions. That is why they have been eager to take orders from those who have possessed, or have been thought to possess, the authority of greater experience: the old hunter, the smith, the chief, the medicine-man. Such authorities were obeyed until, despite all their excuses or alibis, they were shown up by sad experience. Obedience first; then refusal of obedience to what did not work—reasoning long after. Back always to experience as the final test.

In the epigraph of his *Second Jungle Book*, Kipling wrote:

> Now these are the Laws of the Jungle
> and many and mighty are they;
> But the head and the hoof of the Law
> and the haunch and the hump is—Obey!

Some say that we are still in a jungle, and they are not referring to those of us who are fighting in the tropics. If they are right, we had better be heeding whatever experience the race has had in getting out of the wilderness. In the matter of emergence from the education-muddle, we had better stick to "first things first." The order that has been followed seems often to have prescribed the roofing and gargoyle-elaboration of the educational structure before the foundation has been firmly laid: the last and most frilly features first.

Discipline does not mean slavish obedience. It means the acceptance of guidance from those who are in a position to know. The military establishment has taught discipline as no other. It has over-taught a narrow type of it in the past. It is not at all likely to do that now; and if it should run in a lot of duds or dubs, in courses or teachers, they would be speedily shown up. For our whole tradition has made us individualistic and averse to militarism. That puts the burden of proof squarely upon this new enterprise. Nevertheless, we have been suffering for some time, in education as elsewhere, from liberty degenerating into license; and a short course in discipline, under such broad-

gauge military authorities as we are privileged to possess, promises to be to us a national asset of the first order.

There remains what is perhaps the supreme educational service to be expected from the project before us: its laboratory training in "democracy." If there is any one stiffener that is needed in a society that is being warped into a manufactured "class-consciousness," it is a mutual understanding between those who are being guilefully persuaded that they belong apart and not together.

There are really no "classes," in the Old World sense of groups of fixed status, in this country. Says Susan Ertz in *Anger in the Sky* (p. 286): "Instead of talking about 'People in different classes' we ought to say 'People of different educations', which is all this class nonsense amounts to."

This service-training is but another exhibition of our national policy of opening equal chances to all, so far as humanly possible. It is at any rate a short course with nothing in it that is capable of being interpreted as formative of "classes." It is a kind of wholesale public school, transcending the local type where the young have long mingled with their fellows and have arrived at a degree of mutual understanding and friendship on a smaller scale. We make children go to school, whether they or their parents like it or not; and we think we are doing a good thing, profitable to us all.

There is nothing like personal acquaintance to remove class-misunderstandings and suspicion in general. Conferences around a table have cleared many an atmosphere; and the homelier and more informal the association, even the mere eating together (the traditional symbol of brotherhood), the more likely are friendly relations to ensue.

This generalization needs no proof. Is it applicable to the association of youths in living and working together at the same tasks for a year or so during their formative period? The only answer is an emphatic *yes*. If there is any course of education that can inculcate and confirm the democratic spirit and do away with all this clacking about "classes" in the United States, here it is. The "buddy" relation between veterans may be a little sicklied o'er with sentimentality, but there is something very real in the sense of having been imbued, by service together, with the same spirit. A year's association of all kinds of young people, side by side under an intelligent discipline, is sure to be an education in itself, and unique, no matter what kind of a curriculum is imposed. It would fit a youth for American citizenship as no amount of isolated book-study could; for it would be a genuine laboratory course in mutuality.

Van Doren writes of army life, in *Tilda*, 1943, p. 119:

> It is no way to live forever, but there is something wonderful about being churned without warning into a crowd, bundled up like a stick with countless others. The point is that no one of them turns out to be a stick. A few of them I detest, and plenty of them are tiresome; but I wouldn't change anything if I had the power. I wouldn't authorize any man of them to be different. After we stop having wars, if we do, we'll still have to see to it that every so often the population gets stirred around—forcibly, I mean, and arbitrarily, so that Citizen 86, 424, 973 finds himself overnight with a pack of strangers from places he never heard of, pitched into an ocean of fresh faces. It gives you faith in the species, in case you have lost it, or in case you have identified it with the few persons chance has decided you were going to live with forever. This is merely chance on a bigger scale, throwing you into the lap of the race.

Van Doren may be sentimentalizing a little; but we are going to be plumped into "the lap of the race," whether we like it or not, more often as time passes; and we had better be finding out what it looks like.

Many an elderly American is convinced that he would now be a better citizen, and a better man all around, if he had had the experience, decades ago, that is to be offered, he hopes, to present-day American youth. And it is not a very long inference that the reflex action of this national service cannot but be a blessing to our educational system in general, if only by impelling it to take up slack and to do a more genuine job. The year or so could be spared without much, or any, sacrifice of anything but gratuitous interpolations that crowd out essentials—especially discipline, upon which the proposed national service would characteristically insist.

THE PROBLEM OF THE AMAZON—II*

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The Questions

Economy. A representation of the commercial movement of the Amazon in the years from 1889 to 1942 by means of a graph would show that the curve of volume rose until 1912 but afterward fell rather precipitately and that it has remained stationary with the exception of minor variations.

This curve tells the complete story of Amazon rubber, its birth, full glory, and final decadence. The complete decline of this main commodity is now postponed indefinitely, thanks to the plans for its re-establishment and to various interceding factors such as the gradual increase in national manufacture of rubber goods. It is unnecessary to rehearse here the well-understood causes of the failure, but the conditions are still the same, and urgent remedies are needed to prevent a new collapse. Amazon economy rests entirely upon this extractive industry, and its successful re-establishment would be impossible in the face of the dangerous consequences of unstable prices for rubber products.

Nowhere in Brazil, or perhaps even in the world, is found a region with an economic aspect so singular as this, where 80 percent of the production is exported and 90 percent of the consumption imported. Furthermore only 10 percent of the exports is destined for the Nation itself, while close to 80 percent of the imports originates in other Brazilian states. Whether due to the relative isolation from the industrial and consuming centers of the Nation or to the greater proximity to the important foreign markets, the fact remains that the great consumers of Amazon products are found outside of Brazil. Thus, not having an important internal market for its products, the Amazon economy is subjected not only to fluctuations arising from international crises or stock-market speculations but also to price fixing by foreign cartels.

Shortly before the outbreak of the present world conflict an animated commercial movement was beginning to take shape, undoubtedly motivated by the necessity of certain nations to create stockpiles of materials against future blockades. It is difficult at present to foresee how the Amazon economy will orient itself, in view of the events which are unfolding so rapidly. Any measures that might be taken now are certain to be affected by the outcome of the war; but even so it is urgent that some means be found to increase the national consumption of Amazon products and also to improve the methods of production. Nothing is gained by having the largest forest reserve of the world if no real advantage comes out of it. Of what good are thousands of native rubber tappers if their methods of extraction are uneconomical? Of what use are these immense, potential resources if nothing is done to convert them into actual wealth?

The present exploitation of Nature is absolutely irrational, and for this reason the results have been and will continue to be false and disillusioning. Whoever visits the commercial districts of the larger towns and observes the furnishings of the various business houses usually gains the impression that everything is only provisional, installed as cheaply as possible so that all could be abandoned at any moment without great loss. This disinterest for the appearance and comfort in the place of work, where it is necessary to remain during the greater part of the day, is most depressing when one thinks of the important financial resources of the heads of the concerns. This is one of a series of details neglected by the businessmen whose ideas have not yet turned to modern methods of efficiency and progress. The addiction to accepted custom is one of the things most responsible for the situation in which the Amazon is involved, and it will not change as long as purely commercial interests remain predominant.

* Continued from page 44 of preceding issue.

Amazon economy will benefit most by measures to abolish the primitive barter of products extracted from Nature. The majority of the local capitalists will not be easily convinced of the benefits to be had by investing their money in new industries to exploit native raw materials or in modern methods of agricultural production. In any product originating in the Amazon can be seen immense possibilities for a lucrative exploitation whether by agricultural or industrial development. Only when this stage of advancement has been reached can the Amazon economy be considered secure from the tremendous crises which affected it in the past.

Parallel with the agricultural development of native crops, certain foodstuffs should be made available in greater abundance by increasing the buying capacity of the people. This should be so regulated as to prevent the complications which follow any price increase for local products and which bring unsolvable problems for employers and public officials.

The business methods of the region, outside the larger towns, are so primitive as to be direct barter of merchandise for produce. Small traders or hucksters traveling in their own boats through the interior do the trading either directly or through a third person. This sort of exchange is unfavorable for organized business because the producer is almost always cheated both in the value of what he gives and receives, but existing conditions make it practically impossible to defend his interests.

In some localities the natives already have a conception of the advantages of working together, which they have learned from the traditional *putirum,* a term applied to community fishing or planting activities. However, cooperative organizations would be handicapped by the lack of means for dividing the profits and paying for personal services.[13] Another obstacle is the people's latent distrust of government regulations. They are afraid to supply any kind of financial data, being accustomed to regard the public administration merely as a system for extracting taxes. Production will evolve into a cooperative plan only through special, semicompulsive methods backed by adequate organization and legislation.

The taxes imposed by the states and towns fall almost entirely upon native production, because real estate, outside of the state capitals and industry, contributes very little. Nearly always a double tax is levied on an article shipped from one locality to another: a tax upon leaving and another upon entering; and in addition a state tax when the origin, or destination, is a state capital. This taxation increases costs but is necessary to finance municipal governments. Unfortunately the present regime allows the burden of taxation to fall entirely on the producer, that is, on the one who feels it most.

Land valuation and establishment of a sound industry, with a consequent improvement in business transactions, will give the local governments sufficient means for their support, leaving untouched the initial stages of production. Reversion of taxes now assessed on producers would result in a trade revival brought about by increased exports.

Those abuses of inexperienced laborers by exploiters, people who unfortunately receive the lion's share, must be terminated once and for all. An end to the sort of business in which labor figures merely as a balancing of the books would realize a better income for the laborer and new investment of capital. The new system would not cause financial loss in any prior agreement because that could be guaranteed until fulfilled. Money in itself has no value, and the necessity of making it produce will cause a search for new investments, perhaps in fields of harder work but yielding results that are more sound and real for both the country and the individual.

Finance. Credit is the basis of economic prosperity of the people. Its absence causes stagnation of all industrial and commercial activities. The almost nonexistence of credit in the region under discussion contributes to the series of factors hindering progress.

Bank deposits are not large, yet they are considerable in comparison to the relatively

[13] This may be explained by the fact that the people of the forest have little or no money. Their commercial transactions are largely conducted by barter, as has been indicated above.—W.A.A.

small importance of the commercial exchanges. However, money is not lacking for bank transactions as indicated by the small rate of interest paid. Investors have little confidence in promoting products liable to fluctuate in value or subject to other unpredictable influences.

Landholdings cease to be a sufficient guarantee when they reach sizes larger than some countries. Nearly all commercial transactions are based more on personal credit than on land ownership. All operations are made on short terms and at a rate of interest that does not invite investment of large sums of money in an industry with delayed returns.

Only the state can assume the responsibility of financing the development of this region, following a plan whereby the present system of exploitation would be slowly replaced by a beneficial one of agriculture.

The Bank of Brazil administers a specialized agreement supported by law to aid agriculture and industry, but apparently the scope is not broad enough to apply in this region where special legislation should be in effect. Fundamental differences of the Amazon make inapplicable the laws suitable for the rest of the Nation.

The red tape and formalities are so discouraging that few people succeed in getting what they need. The limited number of banks, all located in the state capitals, makes borrowing difficult for the small farmer who lives in remote places and has little time or resources to go to them. Thus, a small loan must be made through various brokers, who absorb most of it in commissions. Consequently, evidence is completely lacking in the interior that the Amazon has had a period of great prosperity. Even the state capitals benefited very little from this former affluence. There was some extravagance, though not to the extent that has been claimed, and under present-day conditions a recurrence would be unlikely.

Even today trading in the more important products—rubber and Brazil nuts—is through commission merchants, known locally as *aviadores,* who sell consignments from the proprietors in the interior and dispatch goods ordered by the latter. Proceeds from sales are used to liquidate indebtedness and commissions previously agreed upon, while any balance remaining is credited to the proprietor. On a smaller scale the proprietor uses the same system in accounting with the men who work for him. Naturally such primitive business methods run counter to the general welfare. Progress can come only by raising the buying capacity of the inhabitants to permit a higher standard of living, instead of a mere subsistence level. The absolute dependence of the producer upon the capitalist is displayed in a number of ways, all of them detrimental for the worker, the producer, the government, and the general economy.

As yet the official institution of credit has done very little for the extractive industries and absolutely nothing to introduce agricultural methods.[14] In view of the peculiar needs of the region, the problem would be solved more logically by the distribution of essential equipment and consumer goods than by loans of money. However, such matters are more difficult than the mere handling of money and books and, consequently, have no place in a banking organization.

Progress could be facilitated by cooperative associations, but unfortunately the working people are not amenable to the idea. Probably they could be taught the advantages of this economic system through school groups, something that has not even been attempted.

There should be no sentimentalism or ulterior interests in conserving outmoded business methods. In this age the individual rights, no matter how strong or legitimate, should yield to the urgent needs of collective rights. A singleness of purpose should be maintained to establish a great collective organization and a true era of economic prosperity in the Amazon Valley.

The solution of this matter of financing is intimately linked with all the other problems. Consequently, a joint plan of action must be guided carefully by the principles pointed

[14] An exception is the recent agreement between the Banco de Credito da Borracha and the Instituto Agronômico do Norte to finance and establish model plantations of high-yielding and disease-resistant strains of rubber trees.—W.A.A.

out in this chapter. The results will be ineffectual unless the various defects are eliminated.

Health. Many have exaggerated the unhealthfulness of the Amazon Valley, but actually the time of plagues and epidemics has long since passed. The prophylaxis for malaria is so well known and easily administered that the disease affects only those who are heedless of elementary precautions. These measures are no different from those which must be observed in wet lowlands not so distant from the Capital of the Republic.

Naturally, in a region where water is the predominant element, represented by thousands of lakes and marshes of all sizes, mosquitoes reproduce on an unlimited scale. For this reason malaria is the great scourge, especially of the poor people. With a lowered vitality they are disinclined to work, and, consequently, careless observers unjustly accuse them of laziness.

The problem cannot be solved by destroying the innumerable breeding places of the anophele mosquito, but it can be approached by the radical treatment of the sick and the carriers to eliminate the sources of infection. Unless science discovers that the disease can be transmitted from other animals, this will be an effective means of control. It does not preclude the employment of chemical or physical methods already in use in other parts of the world. Also, biological methods should be sought through research on the natural enemies of the insect.

In addition to malaria, various other ailments common to the whole of Brazil contribute to the debility of the rural populations here. All are easily treated and can be avoided by simple sanitation and by a slight improvement in the standard of living for the individual.

To talk of leprosy as a problem is to ignore the great accomplishment of the Federal Government and the private organization directed by Miss Eunice Weaver in eradicating this disease from the country. The original program is being vigorously carried out and should soon attain its end.

Tuberculosis, another great reaper of lives, is more a social than a sanitary problem, being limited almost exclusively to the larger towns and cities crowded by poorly nourished people. The only hope for improvement will be better living conditions and education in proper food habits. Naturally the extent of this education will be limited by the local availability of milk, fruit, meat, and green vegetables, but the increased production of these foods will be a task for those concerned in solving the problem.

Only a highly successful campaign against undernourishment will reduce the present high infant mortality, which, according to official records, is largely the result of malnutrition. It must be admitted that living conditions are more than half responsible for the health of the population, and in a region where pauperism exists it is surprising to find neither a high lethal index for certain diseases nor recurring epidemics.

The inadequate hospital service is a serious matter. There exist for this vast territory only thirty-five hospitals and *casas de saúde* (nursing homes), with a total capacity of 3,549 beds.

One of the major factors hindering the achievement of any comprehensive sanitation program is the sparse population, widely dispersed in tiny settlements throughout the region. The tremendous amount of money needed for an adequate project would far exceed the financial ability of the country. An example of this can be shown in the costs for sanitation operations near Belém; in an area of about 2.5 square miles, where the airport and other installations of the SNAPP organization[15] are located, more than $12,500 has been spent without complete eradication of mosquito larvae.

The only expedient plan will be the selection of special areas for sanitation, but to attract settlers these areas must also offer some sort of remunerative employment. This again illustrates the complete interrelation of all aspects of the Amazon problem.

The magnitude of the problem should not weaken our determination even though a lifetime be needed for an ultimate solution. The errors of the past must be avoided, especially

[15] SNAPP is an abbreviation of the title—Serviços de Navegação da Amazônia e de Administração do Porto do Pará.

the selfish attitude of accomplishing no more than one's official duties. There should exist a deep conception of the eternity of Brazil.

Transportation. At first glance it might seem to a casual observer that transportation in the Amazon did not constitute a problem. The impression that all parts of the region are readily accessible because of the magnificent network of rivers is only partially justified. Various facts indicate the complexity of the situation.

To begin with, the rivers constitute, so to speak, merely the main roads, but there are no lateral branches to transport products from the zones spreading out from both margins. Such transportation cannot be accomplished economically because a capricious Nature has given an arbitrary orientation to all navigable tributaries such as creeks and draws.[16] Only man will be able to bring about the necessary changes, but the construction of land highways will prove very difficult.

The question of fuel is most important. Coal is too costly because there are no nearby mines, and so wood must be used instead. But this fuel presents a number of disadvantages. The supply is undependable because 60 years of woodcutting along the margins of the rivers has resulted in a scarcity of trees to fell. The lack of replanting has left only a skimpy second growth to feed the furnaces of the steamers for a greater part of their routes. Transportation costs are increased by the frequent stops to take on fuel and by the reduced cargo space. Wood has inferior combustion qualities and furthermore is usually water-soaked from the lack of shelters in the supply ports. Woodcutters are prone to abandon their hard work and take up more lucrative occupations whenever there is a price increase for native products. Because of this the crews and passengers of boats have at times been obliged to cut enough wood to proceed on their journey. The recent increase in rubber prices will make the situation even worse.

Another factor contributing to the irregularity of the transportation schedule is the dispersion of small settlements along the rivers, some even in the headwaters where the depth of water is slight during a good part of the year. The Territory of Acre, one of the three administrative divisions of the Amazon, suffers most from inadequate transportation during the dry season. Thus, cargo and passengers bound for this region are subjected to tedious delays and reshipping, which are reflected in greatly raised costs of all goods consumed there and in ruinous economic effects.

Whoever takes the trouble to read the manifest of a ship in transit will be surprised at the great number of ports of visit, for many of which only a single parcel is delivered. To know that a ship may lose as much as three hours in delivering this package better explains what navigation on the Amazon is really like.

All this indicates the importance of more accessible populated centers and the adequate development of agricultural wealth. The unstable production of the past has discouraged measures that might have been taken to improve the situation. Conditions will not change until a uniform and dependable volume of cargo can be assured.

The number of ships in traffic has been decreased in the past 20 years by 140 vessels of varied tonnage. Nearly 80 were lost in accidents, and the remainder were sold to other parts of Brazil or to foreign countries. The need for these ships is most acute at the present time.

However, the situation is being improved somewhat by the activities of the SNAPP organization, recently created by the Federal Government to take over the duties of the English companies which operated in the region during the last rubber boom. The law was designed to protect the Amazon Valley by conserving the profits accruing from transportation of its products. The policy is well expressed by giving the new organization wide authority in applying all revenues for the benefit of the Amazon proper. This arrangement has produced some notable results in spite of the mounting difficulties in securing essential foreign materials now controlled by international agreements. An

[16] In the original text there appears the word "igarapé," an Indian word meaning literally "canoe road"—W.A.A.

example has been the construction of one ship of a badly needed type, using native materials in so far as possible and only Brazilian workmen.

All the ships in actual use are old, and their constant repair is a perennial expense which has to be deducted from the small profits. No satisfactory navigation service can be maintained under these conditions without an appreciable deficit. The distances to be traversed are enormous, and practically all the provisions to be consumed during the voyage have to be stocked in the base port. A sudden accident can lay up a ship for many days until repair materials can be brought from some city along the route.

The ship is the only link between civilization and the Amazon jungle, and the cities and towns are as isolated as islands in the middle of the ocean.

Only three short railways are found in the Amazon region. All are situated at the margins of the Valley as follows:

Madeira–Mamoré (235 miles), connecting Porto Velho on the Madeira River with the Guajará Mirim on the Mamoré. This serves Bolivia better than it does our country. The construction work was a veritable epic, and hundreds of crosses along the way mark the struggle of man against Nature.

Bragança (186 miles), which connects Belém with the town of the same name almost at the edge of the Atlantic. The elevated, dry lands along the line are suitable for cereals, but production has been insufficient to bring any improvement of the railroad, which needs to renew its now quite dilapidated rolling stock.

Tocantins (56 miles), which was planned to avoid the dangerous navigation of the Tocantins River. In spite of an immense quantity of abandoned material, the construction of this railway has been paralyzed for more than 20 years. The reasons are not yet well understood, but they would seem to be the same as those which prevent the opening of a highway in the same region.

Attempts already initiated for a road across the Tocantins Valley have been systematically defeated, apparently by ulterior interests of proprietors of large landholdings. They fear the loss of profits derived from their monopoly, which binds the people to the present barter system. To bring progress to the Amazon will require grim determination because man's obstructiveness is often greater than Nature's.

The development of highways is almost nothing, there being less than a thousand miles. The roads are constructed of earth with no top dressing, and during the rainy season they are practically impassable except through constant repairing, which is usually neglected.

River transportation is inseparably united with the future of the Amazon; it cannot be otherwise. In fact, some viewpoints are so deepseated as to consider this to be the only problem of the Valley. A careful study will show this to be not entirely true; navigation constitutes a problem only because it has been made so by other phases of the Amazon question.

The need for a better fuel causes most concern at present. Perhaps the petroleum in the Amazon Basin, unfortunately not yet found in Brazilian territory, will eventually solve this difficulty. The Amazon is the only outlet for the immense deposit discovered along the banks of the Pachitea, a tributary of the Ucayali River in Peru, but the oil will be used primarly to benefit the region where it is located. To bring this oil to Brazil will present great difficulties, not only those of Nature but also those brought about by the world oil trust.

Establishing permanent trading posts to reduce the infinite number of stops for the ships would save time and fuel wasted in the present erratic routes.

The renovation of the fleet, impossible at present, must be done in the not very distant future, because the great majority of the ships have reached the limit of usefulness. Certainly the future iron industry of the Nation will produce the material necessary for the complete reconstruction of the fleet, thus permitting the return of the golden age when of the 303 ships registered in Brazil, 220 were plying the waters of the Amazon. This past magnificence must return to the Amazon, but only an economic stability can make it permanent.

Communications. Establishing a chain of rapid communications connecting all the scattered towns is most vital for the economic and social structure of the Nation and should merit serious consideration on the part of administrators of public affairs. Intercommunication is fairly well developed in the southern and central parts of Brazil but is still quite deficient in the Amazon.

This is especially true of the telegraphic systems. A cable line is limited to the main towns along the river proper, while radiotelegraphy serves only a few cities. A land line is maintained with great difficulty due to frequent breaks in the wires caused by falling trees.

The situation can be improved only by a wider use of radiotelegraphy, and a good step in this direction has been the installation of stations on all the SNAPP ships. However, this service is somewhat inadequate because the ships are constantly on the move. A much better plan would be the gradual installations of stations in all sizable towns.

The use of home radios, of course, presents great advantages, but this must wait until a later period when the people will be prosperous enough to buy the receiving sets.

Postal communications increased immensely with the introduction of air routes, but only the more important cities have been helped, the smaller places still remaining isolated, many of them having no contact with the outer world for long periods. Boat mail can no longer be considered adequate in this hurried world where minutes are worth money.

In the event that the commercial air lines were found to be incapable of supporting themselves, then the military air service could be called upon for aid. Landing fields are still too few to permit any great extension of lines, but the larger towns could be lawfully obliged to clear land and prepare suitable runways.

Any program of development for the Valley must depend essentially upon rapid communications to coordinate the various aspects of labor, sanitation, and settlement of people in the new towns to be created.

The Amazon is extremely isolated from the rest of Brazil; aside from the telegraph it can be reached only by boat or by airplane. Whatever enterprise is undertaken to end this situation will render great benefits, not to mention military advantages.

In this hurried age when the world can be encircled in a few days it becomes imperative that swifter and more efficient systems of communication be brought to the Amazon; to the people who have had so little and who, until recently, have been so scorned.

Social relief. Among the functions of the modern state social relief stands out most prominently because it is dedicated directly to the individual or family. This new term, now widely known, signifies one of the most noble tasks to which a public or private organization can devote itself. Social service is expressed by various means and forms in the larger cities of Brazil but practically does not exist in the Amazon. Aside from the small religious organizations, limited in scope because of their scanty resources, nothing else is found which can be called social relief. The absence of great fortunes, the disinterest of man for his less favored brother, and the insignificant revenues of civic governments are the prime causes of this situation.

A great impetus in the general work of sanitation and education would come in the creation of a mobile corps of social workers, preferably constituted of women who could be recruited easily and rapidly. This organization, perhaps having a semimilitary form, would have as its work the dissemination of general instructions on hygiene, prenatal and postnatal care, home planning, and the assembling of family records for a better understanding of living conditions.

In addition, a multitude of small but indispensable services could be performed in helping the individual to feel less crushed by the immensity of the jungle and to have a desire to improve his way of living. The inhabitant of the Valley, for reasons already known, is indolent and listless. He leads an almost vegetative existence, when instead he might have, if not for himself at least for his children, comfortable surroundings and prosperity from the vast riches which Nature has placed at his disposal.

For this and other reasons, it is imperative that the rights of the working man be protected so that he will not be subject to the exploitation so frequently practiced by those who are not ashamed to take advantage of a faulty legislation to accumulate riches at the cost of misery among their fellowmen. Economic wealth and continuous welfare service can be expected only from well-organized labor, truly oriented along technical and social phases. It is precisely in the Amazon that man, because of his isolation, receives least benefit from the existing social laws. The New State designed these laws to protect the worker, to keep him from being used as a mere tool, which is thrown aside once it becomes old or useless. Provisions which are beneficial in other parts of Brazil are not necessarily applicable here because different conditions need different legislation. A statute should be established immediately to regulate the relations between capital and labor in the Amazon and to bring better enforcement of the law for the protection of the working class.

Lowering infant mortality, sending children to school, keeping workmen out of the tavern, stimulating the organization of the family in legal molds, and teaching patriotism are other tasks which can be performed by the social service to bring real benefit to the abandoned people in the greater part of the Amazon. For the success of the program there are necessary the special gifts of abnegation and devotion, found only in women. Doubtless many of them are merely waiting for an opportunity to serve their country.

A Protestant missionary organization, fully understanding what is most practical for propagation of its ideas in this region, has adopted these methods in part. Using appropriate boats, the missionaries go in search of future converts, traveling the swamps and streams to carry spiritual comfort, medicines, and instruction. The results have been magnificent, and only scanty finances limit these activities so worthy of applause and imitation.

In this critical moment in the history of humanity, when a universal catastrophe threatens to subvert the foundations of society, there is great uncertainty for the future. Living conditions become more acute day by day. Now would be the time to encourage and befriend the unfortunate and destitute to help them resist the avalanche and to construct a smiling future within a great Brazil.

The Solution

Unity. Since, properly speaking, there are not several Amazon problems but rather a single one, likewise one general solution is possible and not individual ones. All the phases of the question are so closely interrelated that only one plan of action, directed by a single organization, will be likely to succeed.

Any specialist, facing the problem independently, is liable to make narrow interpretations which disregard other aspects of the subject; consequently, his conclusions will be unsound and of no value in solving the problem. Of course, each facet of the great general problem should be studied by specialists, but only a peculiar supervising organization of wide vision and autonomy could determine the proportion of work which fits each of these elements. The different operations must be so articulated as to transform the present insecurity into a completely stable condition.

Apparently, then, the best organization would be so integrated as to allow solution of individual questions by subordinate though independent offices; but with all conclusive data channelling through the supervisory board for final interpretation and application. In this way the programs of the separate units could be welded into a plan of unified action to attack the peculiar problem of the Amazon with all its interdependent and correlated phases.

Nothing is to be gained by a sanitation program in a region which can have no towns, and much less by directing a migratory current to a place that is not healthful. To arrange transportation for a zone which produces nothing is equal to increasing production in an area that has no transportation.

These remarks should not be interpreted as destructive criticism against the efforts now being made. The authorities in charge ap-

parently have a widely constructive viewpoint and are fired with determination to bring forth impressive and permanent results, but without a strict and essential coordination the efforts will be fated to complete failure in so far as the rebirth of the Amazon is concerned. There can be seen a considerable dispersion of forces in the existing multiplicity of administrations, organizations, services, and plans, when better advantage would come by directing all into one united action.

In this period of enormous sacrifices we are in no position to continue and much less increase unprofitable expenditures; every cent invested by the public treasury must be transformed into something useful to the general welfare.

An efficient administrative service for the Amazon absolutely cannot be located outside of the region. Furthermore, it is something which only the Federal Government can undertake. Uniformity of legislation can be imposed by means of a special statute to regulate fiscal or administrative activities which might interfere with the development of the organized plan.

A decisive moment has arrived in our economic history, and never before has so much been spoken or written, true or false, about the Amazon in relation to this subject. The entire region, faced toward the future, with its eyes on the Chief of the Nation, awaits anxiously and confidently for the fulfillment of the promises which have been made.

Technique. In choosing plans of attack a knowledge of the subject is essential, but in final analysis the method of applying the plan will count most. Nothing is gained by arguing that this or another plan is the better way of solving a particular case, because there yet remains the task of translating the plan into action to achieve the desired result. Since the Amazon differs in all aspects from the rest of Brazil, it is logical that the courses of action to be adopted shall have to be different also.

These methods would constitute what might be called a special Amazon technique and are not to be understood by making a rapid trip through the region or by reading a few books written by people who likewise paid brief calls. All the factors outlined in the first part of this work must be considered, and all the causes of the complex questions must be understood perfectly. Prompt action must be taken to correct mistakes and failures apt to interfere with the program, no matter how perfectly conceived. The powerful interests involved within the intricate economic mechanism will cause conflicts, but the frequency of such clashes depends upon the steps taken to anticipate them.

Immediate results should not be expected, because they will not materialize. The man chosen to direct the program should be inherently patient. The seed is planted only after the soil has been prepared, and the final harvest depends upon the care given to the different stages of growth.

The foregoing explanations should indicate the futility of any composite plan that attempted to cope with this vast territory as a whole. Knowing the diverse questions, and the agency specially qualified to solve these questions being established, the next step would be to select a limited number of zones for the initial trials. The results from these experimental areas would furnish sufficient experience and data to extend the operations progressively to other parts of the Valley.

The selection of the test areas should not be influenced by politics. The best criteria would be guided by the following:

1. To be easily accessible for year-round navigation.
2. To have a reasonable density of population.
3. To have abundant natural resources.
4. Not to be subjected to periodical flooding.
5. Not to be inhabited by savage Indians.
6. To be centrally located in the geographical divisions of the Valley.

Once the zones are established, attention should be given to the primary objectives with due thought for immediate consequences and alternatives in order to deal promptly with any emergency that might arise.

The experimental plantings in the Ford concession on the Tapajós River, even though confined to the single specialized crop of rubber, can serve for observations of methods

already tried. The mistakes made there can be avoided in the future; they caused the loss of millions of dollars and much precious time, neither of which can be afforded by us.

The experience and observations of the native are not to be scorned but should be carefully examined to eliminate useless or harmful details.

After the first objectives, the subsequent ones should have time limits set for their completion, which will be realized in proportion to the degree of efficiency attained.

One of the principal conditions for success calls for an organization with perfectly harmonized functions, where every member comprehends thoroughly the desired ends in order to proceed intelligently and not as a mere machine.

To advance some services ahead of others might result in a useless loss of time and money. Thus, laborers should not be sent to places where the supply of provisions and tools is uncertain because of transportation. It is important that a regular supply of materials be previously assured because local resources are practically useless without some means of providing their movement from place to place. Suitable boats are not easily constructed at present, and consequently, until this deficiency is remedied, all transportation will have to be adjusted to the capacity of available craft.

Few, or perhaps none, of the enterprises already achieved in the world can serve as a model for the one now being envisaged and discussed; consequently, the lines of action should not be based on hard-and-fast rules. Progress should be made from simple, easily executed measures to more complex ones, avoiding the failures so frequently caused by unnecessary complications arising from an inadequate understanding of a situation. Evidently, then, one detail of the technique to be used indicates a guidance more by common sense than by dogmatic procedures, which are not applicable for a region still in the infancy of civilization. All the rest can be condensed into two simple words: *work* and *honesty*.

Determination. In overcoming a difficulty nothing is more important than a firm determination to master it. This determination is innate in the individual or else he acquires it from the interest taken in the problem to be solved. Thus, an important point for the success of any proposal for the renascence of the Amazon will be found in the choice of the men to direct the program.

When yellow fever threatened to invade the Amazon, in a form that would have wiped out all human life, the one man who knew what to do was Oswaldo Cruz. He was confronted by the task of extraordinary magnitude, but he accomplished it perfectly.

But for the indomitable energy of Pereira Passos perhaps the Brazilian capital would not now have its monumental appearance of which all Brazilians are so proud. The country's history contains names of many illustrious patriots who were able to complete the missions given them, despite all the difficulties encountered. Men of this calibre should be assigned to carry out the plans for the revival of the Amazon, because it will be the work of a giant and a task sufficient to require a lifetime.

It would be a shame to lose more precious time in the present situation by having an incompetent leader, whether by indecision, indolence, dispersion of activity, or above all by disinterest in the subject, either from ineptitude or ulterior motives.

Many individuals still hope to continue the *status quo,* some for fear of losing a source of easy riches, others believing that any change might prejudice organizations already established. It is here that the mettle of the leader will be demonstrated in his ability to deal with the criticism and resistance certain to break loose when the first measure in favor of the general welfare runs counter to private interests.

Certainly no one could exercise such great powers without complete support from the Leader of our country. Likewise it is true that the one chosen should be deserving of the trust placed in him, directing into a single channel all his creative and constructive ability, without hindrance from matters of secondary importance, keeping ever in view the supreme goal to be reached—*The Good of Country and the Aggrandizement of Brazil.*

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TO A REALM UNREAL

I wonder as I gaze at lowering sky,
Elusive mask to curvature of space,
Wherein dimensions lie, three straight and time,
What spirit guides the cosmic realm and why.

I linger on and let my dream thoughts ride
The ether waves that penetrate their course
Unto dimensions' end, then forced to bend,
Righted by the guiding hand of Heaven,
There come whisperings that tell of unknown worlds.

In dreams I build a scaffold to the sky,
I climb its outer dome and listen to
The music of the spheres as they go by;
I tread the golden cupola and try
To put to test my childhood's sense of Heaven.

Reverberating clash then spills my vision,
Realities my reveries dispel,
Space-time, unreal, is but a fashioned frame,
Unmeasured rounds of Heaven, bounds of Hell.

—W. B. Pietenpol

Department of Physics,
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UNITED STATES RESTRICTIONS ON ARGENTINE BEEF

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ONE of the greatest causes for friction between the United States and Argentina arises from our refusal to lift restrictions on the import of Argentine beef. The main reason given by American cattlemen is that Argentine cattle are affected by foot-and-mouth disease, a highly contagious disease whose effects are greatly feared in the United States. Argentine cattlemen say the real reason for American restrictions is the fact that American beef producers fear competition from Argentine beef on the American market, and to avoid this competition they hide behind *aftosa* (Spanish for foot-and-mouth disease) merely as an excuse for excluding Argentine meat. The writer will examine the merits of the two view points on the following pages.

Foot-and-Mouth Disease. Foot-and-mouth disease, endemic in Argentina, is one of the most widely spread diseases attacking cloven-footed animals. The United States Department of Agriculture lists the following countries in which the disease exists:

> Albania, Arabia, Argentina, Belgium, Bolivia, Brazil, Bulgaria, Burma, Ceylon, Chile, China, Chosen, Czechoslovakia, Denmark, Ecuador, Federated Malay States, Finland, France, Germany, Great Britain, Greece, Hungary, India, Indochina, Iran (Persia), Iraq, Ireland, Italy, Luxembourg, Netherlands, Northern Ireland, Norway, Palestine, Paraguay, Peru, Philippine Islands, Poland, Portugal, Rumania, Spain, Straits Settlements, Sweden, Switzerland, Syria, Thailand (Siam), Turkey, Union of Soviet Socialist Republics (Russia), Uruguay, Yugoslavia, all countries on the continent of Africa other than the Union of South Africa. . . . (Bureau of Animal Industry Order 373, October 26, 1940.)

Foot-and-mouth disease is characterized by an eruption of blisters or vesicles (Fig. 1) on the mucous membrane of the tongue or tissues of the mouth, on the skin between and above the toes of the feet (Fig. 2), and on the teats and udder (Fig. 3). As a rule vesicles rupture within a day leaving a raw, red surface. Excessive salivation occurs in cattle.

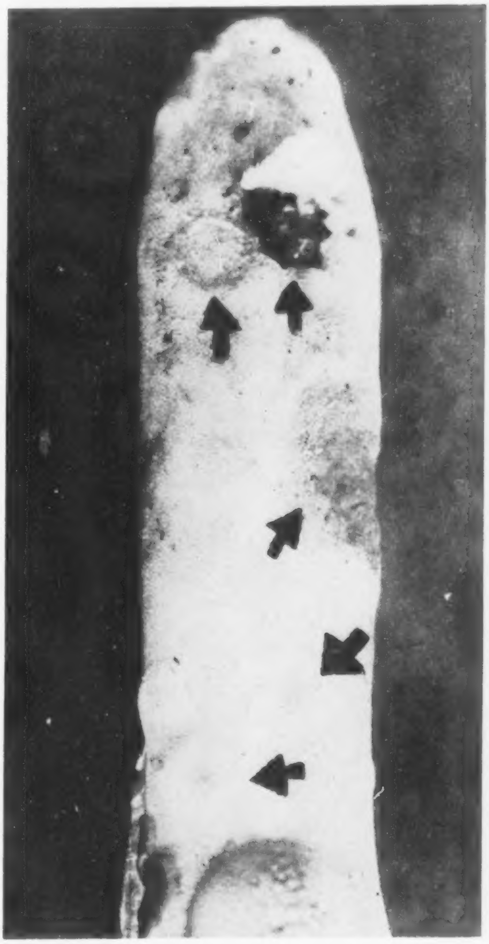


FIG. 1. INFECTED TONGUE[1]
FROM A COW WITH BAD CASE OF FOOT-AND-MOUTH DISEASE. THE DARK AREAS ARE VESICLES. THE ONE ON THE LEFT WITH FLAP IS FRESHLY BROKEN.

Lesions heal rather rapidly, but in some instances those of the feet may give rise to serious secondary bacterial infections. Be-

[1] Figures 1–3 are published by courtesy of the Bureau of Animal Industry, U. S. Department of Agriculture; figures 4–8, by courtesy of Ministerio de Agricultura de Nación, Dirección de Propaganda y Publicaciones, Argentina.

FIG. 2. FOOT LESIONS
THE ULCERATION OF THE TISSUE BETWEEN THE TOES MAY EXTEND TO THE LIGAMENTS OF THE FETLOCK OR PRODUCE DISEASE OF THE JOINT OR OF THE BONE.

fore and for a short time after appearance of lesions a striking rise of temperature occurs, and during the attack animals lose considerable flesh. When cows contract the disease, a severe reduction of milk flow results, and cases of abortion are numerous among pregnant animals.

Mortality is usually light, often not more than 3 percent of the herd. Once in a while, however, losses may reach 30 to 50 percent as they did in certain European herds during severe attacks between 1918 and 1921. If the animal recovers, a time lapse of from ten to twenty days is the rule in mild cases, but the disease may linger from three months to a year in malignant form.

Financial losses from the disease may run into millions of dollars. In Germany during the attacks of 1920 and 1921 estimated damage was approximately $119,000,000. This does not include expense resulting from disruption of business caused by quarantine restrictions. In Switzerland losses during the same years reached $70,000,000. Swiss figures may carry fuller significance if it is noted that the number of susceptible animals in the republic at that time was only one-fiftieth the number in the United States; and that the area of Switzerland is less than one-half that of the state of Maine. The most severe outbreak in the United States was that of 1914. It cost about $9,000,000 to eradicate the disease by slaughtering 172,000 animals: 77,000 cattle, 85,000 swine, 10,000 sheep, 11 goats, and 9 deer. Other less costly outbreaks in the United States have occurred in 1870, 1880, 1884, 1902, 1908, 1924 (twice), and 1929.

The first epidemics in the United States were introduced by imported animals affected by the disease, but later infections were carried by some such means as hay, straw, halters, ropes, hides, hair, wool, or garbage. The 1929 occurrence in California was traced to garbage from a trading steamship docked at San Pedro. The ship had taken on fresh meat in a South American port.

The infective agent is a filterable virus present in the fluid and coverings of the vesicles, in saliva, milk, urine, or other secretions and in bone, meat, or blood of the affected animal. The virus does not always die rapidly. Definite evidence is available to show that in one instance the infective agent persisted in a field for 345 days; yet a

FIG. 3. BLISTERS ON THE TEATS.
IN CASES OF SERIOUS AFFECTION OF THE UDDER, TEAT PASSAGES MAY BE CLOSED, RESULTING IN A CAKED UDDER; AND TOXIC POISONING MAY ARISE FROM IT.

FIG. 4. HERD OF FAT CATTLE ON PASTURE IN THE ARGENTINE PAMPA
MOST OF THESE ANIMALS SHOW A SHORTHORN STRAIN, A BREED ACCOUNTING FOR MANY ARGENTINE CATTLE.

temperature of 140° F. (60° C.) will destroy the virus in from 5 to 30 minutes. In 1942, after many British epidemics had been traced to feeding unboiled swill to swine, a law was enacted declaring the feeding of unboiled swill or allowing animals access to raw bones or unwashed meat wrappers a statutory offense.

It is upon the question of length of life of the virus in frozen and chilled meat that difference of opinion exists. Felix J. Weil in his recent book *Argentine Riddle* states:

> British Foot-and-Mouth Disease Research Committee established that the virus does not remain alive over 42 days in the blood of frozen carcasses nor over 76 days in the bones. Consequently, a quarantine of 21 days for imported boneless meat, added to the 22 or more days it takes to bring a shipment from Buenos Aires to New York, should be more than sufficient precaution.

Mr. Weil does not tell the entire story. The Second Progress Report of the British Research Committee shows that virus remained alive in bone marrow up to 87 days, in kidney 83 days, and in guinea-pig pads 102 days. Other work reported by the Committee (Fourth Progress Report) demonstrated survival of the virus at −2° C. for 82 days in tongue, 99 days in liver, 96 days in kidney, 107 days in bone marrow, and 145 days in tendon. Continuance of the work with larger numbers of animals slaughtered in the infective stage of the disease and more numerous inoculation and feeding experiments may show longer periods of survival.

From the above statements it is evident that foot-and-mouth disease research is active. Owing to the great infectiousness of the disease, experiments are not conducted within the United States. Experimental work by the U. S. Department of Agriculture has been done in foreign countries by arrangement with their veterinary and other public officials. Various vaccines have already been discovered, and some of them are said to be highly successful. No doubt, in time, vaccines will be found which may prove as great a boon to the world beef industry as present-day hog cholera vaccines and serums are to the swine industry. In spite of research progress, however, more evidence seems needed on the life of the virus in

boned, frozen, and chilled beef before shipments from infected areas may be admitted safely into the United States.

Noninfected Areas of Argentina. Argentine cattlemen would probably object but little to quarantine against meat coming from those parts of their country where foot-and-mouth disease is endemic. But they do object strenuously to a blanket sanitary barrier against the whole nation. Prior to 1930 the restrictive sanitary measures against importation of chilled and frozen meats from countries affected by the disease applied only to *regions* within such countries where infection was known to exist. With the coming of the Smoot-Hawley tariff act, however, embargoes were applied to every part of a country in which infection exists or which has been exposed to infection, even though well-defined areas of the country are known never to have been affected with or exposed to foot-and-mouth or any other objectionable disease.

In a letter to Senator Key Pittman, Chairman of the Senate Foreign Relations Committee in August 1935, ex-Secretary of State Mr. Cordell Hull, had the following to say concerning infected regions and countries:

A serious barrier to international trade is found in sanitary measures which restrict trade more than is necessary to accomplish the purposes for which they are imposed. For example, on Jan. 22, 1929, the United Kingdom placed an embargo on animals, hay, straw, and alfalfa meal imported from Colorado. The reason given for the embargo was an epidemic of foot-and-mouth disease then prevalent in California. Protests were made and following the determination of the fact that the disease was restricted to California, the embargo on products of Colorado was lifted in February of that year. On May 2 1932, because of an outbreak of foot-and-mouth disease in California, an order was issued in the United Kingdom prohibiting importation of live ruminants, swine, hay and straw from any part of the United States. On May 21, it having been discovered that the outbreak was local to California, an amending order was issued limiting the prohibition to products originating in California. In the meantime, however, the application of the prohibition to the whole of the United States had acted to the detriment of the non-infected districts. I cite these

FIG. 5. CARCASSES COOLING IN AN ARGENTINE PACKING PLANT

FIG. 6. CUTTING ALFALFA HAY ON THE PAMPA

MOST CATTLE ARE FATTENED BY PASTURING ON ALFALFA FIELDS, A MARKED CONTRAST TO U. S. CORN FATTENING.

examples to show the harmful effects of embargoing products of a whole country when only a part of that country is subject to infectious or contagious disease. It is difficult to make representations against such practices by foreign countries when we ourselves have a section of the Tariff Act which appears to foreign countries to be a glaring example of such legislation. Our own practice is even less defensible than the examples I have cited, when, as in the case of Argentina, the embargo on meat applies against a large section of the country which our own experts hold to be free from foot-and-mouth disease.

Article Three of the Sanitary Convention of 1935 takes care of the objectionable word "country" in the Smoot-Hawley Tariff Act of 1930. "Country" is the word replacing "region" of the previous sanitary enactments. Article Three reads as follows:

> Each Contracting Party recognizes the right of the other party to prohibit the importation of animal or plant products originating in or coming from territories or zones which the importing country considers to be affected with or exposed to plant or animal diseases, or insect pests dangerous to plant, animal or human life, until it has been proved to the satisfaction of the Party exercising such right that such territory or zone of the other Party is free from such contagion or infestation or exposure to contagion or infestation. Neither Contracting Party may prohibit the importation of animal or plant products originating in and coming from territories or zones of the other country which the importing country finds to be free from animal or plant diseases or insect pests or from exposure to such diseases or pests, for the reason that such diseases or pests exist in other territories or zones of the other country.

Ratification of the Sanitary Convention Between the United States and Argentina, signed May 24, 1935, seems advisable. Argentines assert that former President Roosevelt, while on a visit to Argentina in 1936, promised Senate ratification. The Senate failed to ratify.

Foot-and-mouth disease is endemic to the Pampa, the great meat-producing region of Argentina (Figs. 4, 5, 6, 7). However, the disease usually occurs in a light form, the reason being, according to some authorities, that the cattle are grazed outside throughout the year. This is possible because of the mild climate, characteristic of the east-coast, subtropical location. Patagonia and Tierra del Fuego have been declared free from infection by Argentine officials. These two regions produce a large fraction of the sheep (Fig. 8) raised in Argentina and also account for a

few cattle. Acceptance of shipments of mutton and beef from southern Argentina would show Argentine livestock men that we are not hiding behind sanitary embargoes to keep out competition.

Argentine Canned Meat. As previously stated, a temperature of 140° F. applied to infected meat will destroy the foot-and-mouth disease virus. Meats for canning are heated beyond this temperature, and so it follows logically that no danger of infection exists from importation of Argentine canned meats. On more than one occasion, lobbying in United States Congress has defeated the purchase of canned meat from Argentina. Specifically, Argentines call attention to the Senate's failure to approve the Navy's purchase of a small quantity of Argentine canned beef in 1939 despite the fact that such canned beef was not produced then in the United States and that the Argentine product is thought by many, the writer included, to be the best and cheapest in the world.

There seems to be no legitimate reason why Argentine canned meats should not enter the United States tariff-free or under a reasonable rate if tariff seems advisable. The United States consumer would surely gain from large shipments in such trade, for it is an established fact that during normal times a large percentage of the United States population suffers from an insufficient meat diet, owing in no small degree to the high price of American beef.

An import of but 2 percent of our annual meat consumption—2 percent made up of canned meat and frozen or chilled meat from Argentine regions known to be free from infection—would take nearly a quarter of Argentina's present meat export and lay the basis for significant shipments of American goods in exchange.

Evolution of Argentine—U. S. Friction Over Trade in Beef. Friction over Argentine beef is of comparatively recent origin. Prior to 1880 little cause for controversy existed, for until artificial refrigeration became

FIG. 7. THE GRAND PARADE OF PRIZE WINNING CATTLE
AN ANNUAL LIVE STOCK SHOW HELD AT PALERMO PARK, BUENOS AIRES. THE GRAND CHAMPION BULL OF 1925, WHICH SOLD FOR MORE THAN $50,000, DIED A FEW MONTHS LATER OF FOOT-AND-MOUTH DISEASE.

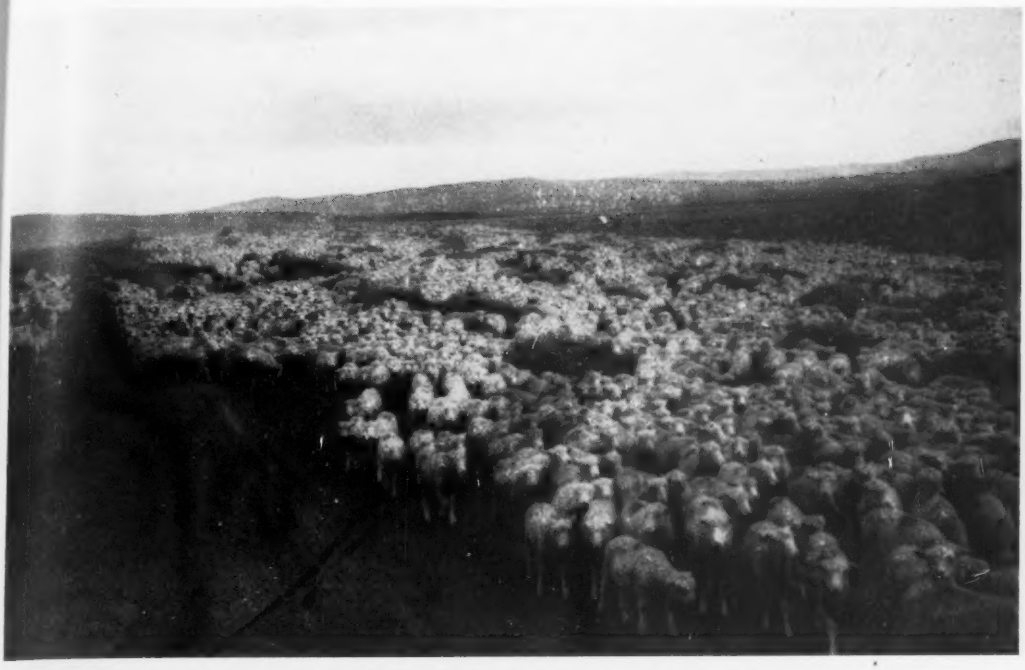


FIG. 8. LARGE DROVE OF MERINO SHEEP IN ARGENTINE PATAGONIA
THE MERINO IS BETTER ADAPTED TO THE ARID PATAGONIAN ENVIRONMENT THAN OTHER BREEDS OF SHEEP.

practical, neither country was able to ship meat with much profit to European markets. The United States was first in making practical use of refrigeration, as it was a simpler problem to ship beef across the temperate latitudes between our Eastern Seaboard and Europe than to forward it across tropical seas between Argentina and Britain. By 1900, however, both countries were competing for foreign markets. This competition did not last long, for growth of population in the United States and per capita decline in beef production in that country finally settled the issue in favor of Argentina.

Paul O. Nyhus in "Argentine Pastures and the Cattle Grazing Industry" (*Foreign Agriculture*, January 1940) gives an interesting comparison for United States and Argentine beef exports. In 1903 United States shipments of frozen and chilled beef to England reached 298 million pounds. Although showing a declining tendency these exports were fairly well maintained until 1907; but in 1908 they fell off sharply and continued to drop until in 1912 they practically disappeared.

Argentine export trade followed an opposite direction. Exports increased from 3 million pounds in 1895 to 53 million pounds in 1900. After that date, expansion was rapid: 330 million pounds in 1905; 548, in 1910; 1,071, in 1918; 1,615, in 1924. From the high level of the period 1924 to 1927 exports declined in 1928 and reached the low average of 839 million pounds for the years 1933–1935. In 1943 beef shipments totaled about 1,202 million pounds.

During the 1930's Britain placed Argentine beef under quota restrictions. Irked by these barriers, Argentina looked elsewhere for a market. The United States was a possibility, but tariff walls and sanitary embargoes have been far worse than in Britain.

Conclusions and Trends. It seems clear, in view of the highly contagious and dangerous character of foot-and-mouth disease, that American cattlemen should be extremely vigilant in keeping the dreaded infection from the United States. Sanitary barriers against animals and meat from regions infected with the disease should be strictly

enforced. On the other hand, it seems just as clear that injustice exists when Argentine livestock raisers in noninfected regions are prohibited from selling meat to the United States. In the last analysis the real basis for present friction over the meat industry is geographic. Location of the two countries in similar latitudes encourages similar production, similar production accounts for trade rivalry, and trade rivalry leads to international friction.

Some years hence, if we do not adjust our differences over the meat trade in the meantime, Argentine beef surpluses will probably cease to cause friction. It is not generally realized that Argentina consumes locally about three-fourths of her meat production. Her consumption in a recent year was 276 pounds of beef, 17.2 pounds of mutton, and 15.2 pounds of pork per capita. With only fourteen million people on a million square miles, Argentina is an underpopulated country. The nation could easily support two or three times the present population. Intensification of agriculture and further industrial development, changes which are likely to come, will encourage population increase (cf. SM, April 1945, p. 257). This in turn may expand beef consumption to a point where little surplus will be left.

Excerpts from B.A.I. Order 373

(The Law on Foot-and-mouth Disease)

. . . the importation into the United States of cattle, sheep, or other domestic ruminants or swine or of fresh, chilled, or frozen beef, veal, mutton, lamb, or pork, from the countries above named [p. 101] is prohibited.

No fresh, chilled, or frozen meat or meat product derived from wild ruminants or wild swine, originating in any country named [p. 101] shall be entered into the United States.

No fresh, chilled, or frozen organs, glands, extracts, or secretions derived from domestic ruminants, or swine, originating in any country named [p. 101] shall be entered into the United States except for pharmaceutical purposes.

Any animals, meats, organs, glands, extracts, or secretions specified [above] offered for entry and refused admission into the United States, shall be exported by the consignees thereof within 10 days or shall be destroyed in accordance with the directions of the Chief of the Bureau of Animal Industry.

No cured meat or product [this does not include any meat or product in hermetically sealed containers which has been sterilized by heat] derived from ruminants or swine, originating in any country named [p. 101] shall be entered into the United States unless the following conditions or requirements shall have been fulfilled: (a) All bones shall have been completely removed in the country of origin. (b) The said meat or product shall have been thoroughly cured by the application of dry salt or by soaking in a solution of salt. (c) The said meat or product shall have been held in an unfrozen, fresh condition for at least 7 days immediately following the slaughter of the animals from which it was derived.

No garbage derived from meats or meat products originating in any country named [p. 101] shall be unloaded from any vessel in the United States or within the territorial waters thereof: *Provided, however,* That such garbage, when contained in tight receptacles, may be so unloaded for incineration or proper disposal otherwise as directed by the Chief of the Bureau of Animal Industry, or it may be so unloaded under the direction of an inspector of the Bureau of Animal Industry for transportation beyond said territorial waters for the purpose of dumping.

No dressed poultry offered for importation into the United States from any country named [p. 101] shall be allowed entry unless the feet of such poultry have already been removed at a point above the spur or spur core, or are removed and destroyed or disinfected at the port of entry as directed by the Chief of the Bureau of Animal Industry. Such removal and destruction or disinfection shall be accomplished by the importer or his agent. . . .

AN ENGLISH PICTURE OF THE UNITED STATES

By WILLIAM LAAS

In the spring of 1943 the Ministry of Information of the British Government published a curious map of the United States that should be prized as an object lesson for atlas makers. The cartographer rarely receives from his ultimate consumer, the general public, a report on the effectiveness of his methods. Here for his inspection is a permanent record of the strange things that happen when people look at maps.

The British MOI, which roughly corresponds to the U. S. Office of War Information (OWI), produced this map as a small poster, 15 inches by 10 inches, for display in "pubs" and other rendezvous of the populace. From the title, "A Map of the United States of America,"[1] the lavish display of red, white, and blue, and the pointed selection of this nation's most superlative features, one infers that it was an effort to paint a reassuring picture of a great ally, at a moment in history when curiosity about the U.S.A. was intense throughout the United Kingdom.

The poster is commercial art rather than a serious job of cartography, apparently a quick tracing from some standard atlas. Thus it is, in effect, a lay interpretation of a published map of the United States, made by a person of education and intelligence, but untrained in geography and unfamiliar with America. The artist put down what he (or she) saw in an atlas, and left out what he didn't see, to include those details of greatest interest to the British people.

American geography is by no means a familiar subject in Great Britain, outside of professional circles. The odd ideas of the United States entertained even by well-educated Englishmen are a subject of humor on both sides of the Atlantic. The numerous errors, omissions, and oddities of detail in the MOI map are the result of this unfamiliarity, plus certain subjective influences and perhaps haste. But many of them are so natural, withal surprising, that they must be ascribed to obscurities in the atlas consulted. They show how the source map was read, or misread; how it failed to set the artist straight.

The users of atlases, American or foreign, must be presumed to lack special training. Some of the ideas that formed in this British mind upon examining a map of the United States may be expected to form in any mind not already familiar, through education, with this country's geography.

Professional cartographers, of whom the writer is not one, may therefore find valuable hints for the improvement of their art in this innocent British picture of the United States. In the following analysis of its detail, the attempt is made to adopt the point of view of the British copyist. The resultant psychoanalysis of a typical map reader may be more provocative than conclusive, but it at least demonstrates that in cartography for the general public, nothing may be taken for granted.

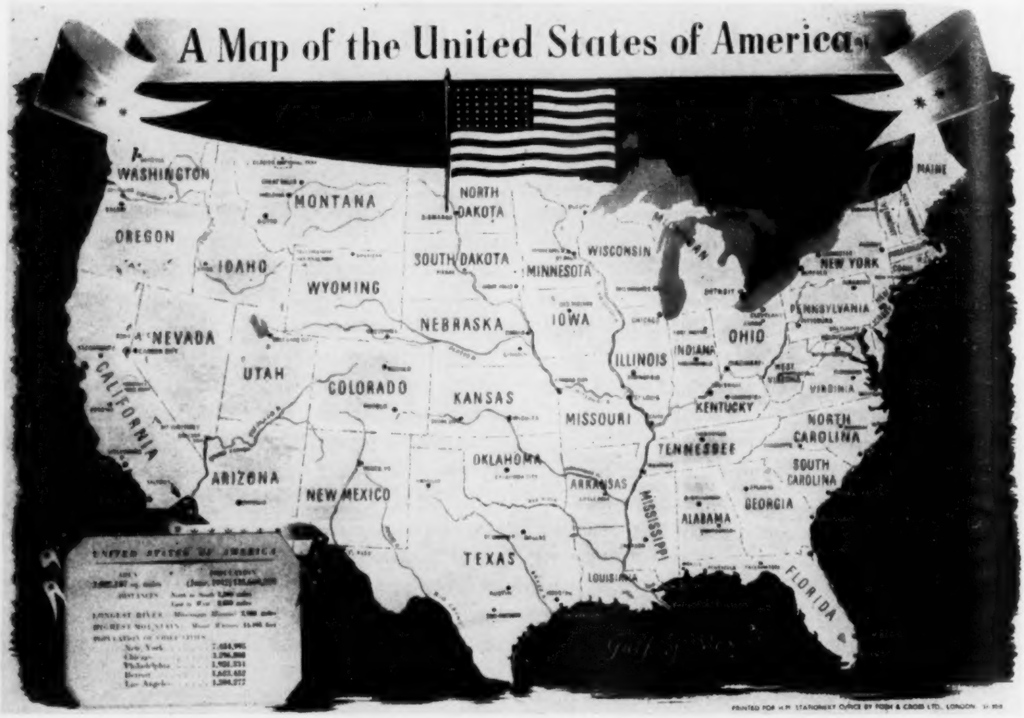
Analysis of the MOI Map

The British artist was greatly impressed by this nation's size, to the exclusion of other pertinent considerations. An inset box, under the heading "United States of America," contains a selection of statistics: area, population,[2] "distances,"[3] "longest river," "highest mountain,"[4] and "population of chief cities" (New York, Chicago, Philadelphia, Detroit, Los Angeles).

The principle of superlatives is pursued into the map itself. Mt. Whitney, the "highest," is the only mountain indicated anywhere; it appears as an isolated peak. All the rivers shown are (with two exceptions) the "longest" in the United States. The largest states, Texas and California, are the most thoroughly documented in place names.

It is likely that this approach was deliberate. As an item of home propaganda, the map's obvious function was to create an impression of size and power across the Atlantic, of an ally upon whose strength England could rely. The artist carried this assumed "directive" to an extreme.

He did not observe any relief, or consider it important. Except for some twelve rivers and the one mountain peak, the MOI poster



map is entirely barren of relief. Thus the United States looks like one vast plain watered by a few great, sluggish streams, a topography akin to that of the U.S.S.R. Moreover, since all the rivers (save the Ohio) are in the West, where they are widely spaced, an illusion of uniformity is created.

One of the freaks of this omission of relief is to give Great Salt Lake a phenomenal outlet. A tributary mistaken for the South Platte River appears to rise in the lake, climb the Continental Divide, and proceed across Wyoming to its junction with the Missouri.

A deduction is that the atlas consulted by the MOI artist did not make evident at a quick glance the general nature of the country's configuration, or give any idea of differences in terrain and natural routes of transportation, settlement, and trade.

The size of the West threw him off perspective in considering the East. On this map place names and natural features are apparently distributed among the States according to the space available. Thus Texas and California appear to possess the largest number of cities worthy of inclusion, while Ohio has only three, and the two smallest states, Rhode Island and Delaware,[5] have none at all.

Eastern rivers are omitted by a similar mental process. Compared on a map to the Mississippi or to the Columbia, the Hudson appears to be only a little river, so not worth including. The boundaries of Western States are drawn accurately, those of the East, inaccurately. The one mountain and the only named lake on the entire map are both in California, and all other such "features" are in the West. They include three national parks (Glacier, Yellowstone, and Yosemite), one natural wonder (Grand Canyon), and one great work of man (Boulder Dam).

Compromise in perspective is a basic difficulty with small maps of the United States, and here appears to be a leading source of false interpretation. The details of the crowded East are too hard to see; those of the spacious West, too easy. Their relative importance is in consequence obscured. The Ministry of Information artist could not have omitted the Hudson River had he been able to recognize it for a mightier waterway than the Thames and a rival of the Rhine.

He did not see boundary lines clearly or grasp their nature. The straight-line boundaries characteristic of the U.S. have always intrigued Europeans. The MOI artist tends to make them even straighter. His atlas evidently was not vivid enough in delineating boundaries to prevent his overlooking their quirks.

Parts of the Canadian and Mexican borders are covered by the decorations, so one does not know how such vagaries as Puget Sound, the enclave at Lake of the Woods, or the mouth of the Colorado might have been handled. The visible international borders are formalized and smoothed; Maine, for example, is almost of geometrical shape. In many cases, the existence of natural boundaries is not recognized. Thus the river-lake system west of Lake Superior, and the river connections between Lakes Huron, Erie, and Ontario are not indicated. Lake Memphremagog becomes a little bump on the Vermont line, and Lake St. Clair a bulge on Michigan's.

Most spectacular omission is the names of the Great Lakes, either collectively or individually. Nameless also are the St. Lawrence River and Lake Champlain, though on the southwest border the Rio Grande is named. Failure to name lakes is general throughout the map, with one unexpected exception. One may speculate how it happened to be Salton Lake, California.

The British copyist's tendency to portray the East with the same broad, bold strokes as the West is also evident in his internal boundaries. State borders are simplified by omission of meanderings and enclaves. Rivers and other natural boundaries are often omitted, and the smaller States get rather severe treatment.

Delaware is simply lost, and appears on the map as an empty panhandle of New Jersey. Rhode Island, labeled "R.I." (which must have mystified many a "pub" patron), is too small to permit including the city of Providence. Connecticut is "Conn." and Massachusetts is "Massachus's." Philadelphia wanders up and across the undelineated Delaware River to become a double city (two red dots) at the location of Trenton, N. J. Alabama's corridor to the Gulf of Mexico is lost by extension of Florida's northern boundary straight across to Mississippi, enveloping Mobile Bay. Even in the West, Nebraska's northern line crosses the Missouri River, nicking off a bit of South Dakota.

Most baffling of all must have been the complex borders of Maryland, Virginia, West Virginia, and the District of Columbia. Virginia's eastern shore on Cape Charles is ceded to Maryland. West Virginia's panhandle is lost to Virginia. The existence of the District is ignored. Washington is located well within the Virginia border, just about at the location of an actual little town in Rappahannock County called Washington, Va. The bend of the missing Potomac becomes a half-square projecting into Maryland, suggesting the squareness of the District of Columbia outline.

Withal, these errors are natural and excusable. If one examines a typical atlas, it becomes evident that many such details may easily be confused by a person unaware of the facts by other means. In England the concept of a Federal District and of the division of a country into sovereign States is only dimly understood, despite Dominion parallels, such as Canada and Australia, and the canton system of Switzerland. Maps do not clarify the point that Washington is in federal territory, as distinct from state territory. Obviously the MOI did not appreciate the absurdity of "Washington, Va."

He was unable to appraise the importance of coastal indentations and waterways. The artist's handling of seacoasts, rivers, and lakes indicates an effort to simplify, but his atlas did not make clear which details should be included no matter how drastic the simplification, and which might safely be omitted. His selections can be accounted for in no other way.

On this map, the outstanding feature of the coasts is the cities, with some surprising results that will be mentioned below. Of the coastal islands, only Long Island is named, with two off Massachusetts, and three off southern California also drawn. Sandspits are indicated along the Gulf coast of Texas and the Atlantic coast of Florida, but the important chain forming Cape Hatteras, and the keys culminating in Key West, are lopped off, lost in the slate colored ocean.

A number of bays are indicated, but just two are correctly distinguished by name. They are (for some reason) Long Bay, S. C.,

and Monterey Bay, Calif. Delaware Bay is labeled "Delaware River" (the river itself is omitted), and San Francisco Bay is called "Golden Gate." (As drawn, the "gate" appears to be about 30 miles wide.) Long Island Sound, Chesapeake Bay, and other important indentations are ignored.

Capes also are nameless, including even Cape Cod. Just one coastal feature is recognized, the Delta of the Mississippi.

Inside the country, the selection of rivers shows that their importance was judged entirely by length. The twelve on the map consist of the ten "longest" rivers in the U.S.A.: the Missouri, Mississippi, Rio Grande, Arkansas, Colorado, Columbia, Snake, Red, Ohio, and Platte (with its North fork), plus the "Brazo" (Brazos) and Pecos, which rank Nos. 12 and 15. Possibly the last two would not have qualified had the copyist noticed the length of the Canadian River, the Colorado (of Texas), or the North Canadian. For on this map there is no Hudson, no Potomac, no Delaware (except for its incorrectly named mouth), no Connecticut, no James, no Illinois, no Tennessee, nor any number of others. The Ohio is the only river east of the Mississippi, and on the map it is nameless.

Lakes, all unnamed except Salton, are handled as isolated bodies of water, with no attempt to link them to one another, as in the case of the Great Lakes, or to the river systems. It is evident that the British artist did not grasp their significance or relationship to the life of the nation. No canals are shown.

He was confused by duplication of names. Whenever the artist encountered a river with the same name as a State, or a city named after a lake, or two cities with the same name in different States, or other such duplications, he usually omitted all but one. The point is admittedly confusing, and apparently his atlas made it no clearer.

There are numerous examples. The omission of the Ohio River's name is probably one. So also is the omission of Delaware, State and river, and the bestowal of the name "Delaware River" upon the Bay. Similarly Great Salt Lake is not named, but Salt Lake City is. "Long Island" serves to identify the Sound as well. Wilmington, N. C., is greatly magnified in importance, quite possibly by confusion with Wilmington, Del., which is omitted. Washington, D. C., must have been mixed up with Washington, Va. There is a city named "San Francisco" but no bay.

He derived no consistent principle from the classification of cities. The cities selected in the MOI map are the most fascinating of all its unpredictable details.

To begin with, the cities are distributed among the States apparently according to the space available. This helps give the map a certain artistic balance which the nation does not enjoy in fact. They are marked with red dots and names of varying size, with some attempt to distinguish them according to importance. But even for the five "chief cities," the distinctions are inconsistent. Important cities are entirely overlooked, while inconsequential ones are included and others are overrated. Here one can appreciate that the artist put down only what was most easily seen in his atlas.

The map creates the illusion that the most important United States cities are all on the coasts. This is partly the result of the color scheme; the names of seacoast cities are in white, prominently "dropped out" of the slate blue ocean background. Also it would be natural for a wartime British ministry to emphasize the convoy ports of the "bridge of ships" to Britain. However, the classification goes awry even within the coastal group.

Here is the list of cities for which the largest and boldest lettering is employed:

Portland (Me.)
Boston
"New York City"
Philadelphia (in New Jersey)
Atlantic City
Newport News
Wilmington (N.C.)
Charleston (S.C.)
Palm Beach
Miami
Los Angeles
San Diego

Any "pub" patron would gather that all of these are the principal metropoli of the United States. Chicago and Detroit, two of the "chief cities" listed in the inset, enjoy

equally large, but much lighter lettering. Because they are in the interior, they pale by comparison with San Diego and Palm Beach.

The category indicated by the next largest size of lettering is equally amusing:

Portsmouth (N.H.)
Savannah
Jacksonville
New Orleans
Galveston
San Francisco

Also featured, by heavy lettering of smaller size, are "Brooklyn" (no doubt for its fame) and Long Beach, Calif. (for some reason). Typical of the muddle is that Norfolk is made to look like an insignificant suburb of Newport News.

Inside the country the name sizes vary practically at random. Cleveland, Cincinnati, Milwaukee, and St. Louis are somewhat larger than most, but the very smallest lettering is assigned to Baltimore, Minneapolis, "Pittsburg," and other vital centers. Seattle and Portland, Ore., are well-nigh invisible.

There is no indication of state capitals, and a number are omitted, as in Kansas, where Topeka is missing but not Dodge City. Washington is not identified as the national capital. In general, cities are omitted or obscured whenever they are in congested or minutely subdivided areas. The possibility that a small State may contain large cities of disproportionate national standing appears to have escaped the unsuspecting artist.

This suggests that typography alone can not be depended upon to classify American cities. The device of representing metropolitan areas on a map as colored areas may solve one aspect of the problem. What is important about Boston is not its "official" population of 770,000, but its metropolitan concentration of 2,350,000. Pittsburgh, St. Louis, Baltimore, Cleveland, San Francisco-Oakland, Minneapolis-St. Paul, and others are similar cases. Providence, in congested Rhode Island, should be as easy to see and as prominent as Reno, in empty Nevada. The MOI artist missed the former but did not fail to include the divorce capital.

Political centers apparently require a more distinctive marker. Washington and the District of Columbia in particular need special handling. The British artist's confusion between size and political function is shared by Americans, many of whom, for example, think of New York as the capital of its State.

Conclusion

The foregoing analysis suggests the conclusion that existing general purpose maps of the United States are most susceptible of false interpretation. Accuracy and much of the significance of details are lost upon the untrained eye. That eye could as well be American as British. The failure of U. S. maps to register facts is less apparent among Americans because geographical education fills in the gaps and unscrambles the detail. In this non-professional British effort the false impressions are absorbed, uncorrected, and set down as gospel.

For example, to a foreign reader, the name "Philadelphia" in an atlas may look as if it were attached to a spot in New Jersey, but an American, attuned to the familiar ring of "Philadelphia, Pa.," does not fall into the error. The foreign reader's mistake thus reveals to us the existence of an unsuspected obscurity in our maps.

The world of the immediate future, it seems safe to forecast, will demand authentic geographical information about the United States. The increasing importance of this country in global affairs will subject it to greater scrutiny abroad; the foreign business man, statesman, and scholar will seek a greater factual knowledge. The long neglect of the subject in the schools and thought of the Old World may be corrected.

Maps will form an important part of this educational reorientation, and the cartographer will be called upon to provide them. American cartographers will be expected to produce the most authoritative maps of their own country, drawn in such fashion that they cannot be misunderstood. The MOI's anonymous and well-meaning poster designer has shown us that they can.

[1] "Printed for H.M. Stationery Office by Fosh & Cross Ltd., London. 51–3018." The last is a code number.

[2] It reads: "Population (June, 1942) 131,669,275." Actually all population figures are from the Census of 1940.

[3] "North to South 1,500 miles. East to West 3,000 miles."

[4] "Mississippi-Missouri 3,988 miles," and "Mount Whitney 14,495 feet."

[5] Delaware is not even included as a State (see *infra*).

THE CINCHONA-BARK INDUSTRY OF SOUTH AMERICA

By WILLIAM CAMPBELL STEERE

ASSOCIATE PROFESSOR OF BOTANY, UNIVERSITY OF MICHIGAN

THE discovery of the antimalarial property of quinine has been called one of the great events of medical history, since it represented the first-known specific remedy for any disease. One seventeenth-century writer said that Cinchona bark was more precious to mankind than all the gold and silver that the Spanish Conquest brought from South America. Nevertheless, the circumstances of this important discovery are shrouded in a great mass of tradition and outright fiction (see SM, July 1945, pp. 17–20). The only really dependable information which we have is that Cinchona bark was introduced into Spain and Italy early in the seventeenth century and that it was distributed by the Jesuit fathers. In the militantly Protestant countries of northern Europe, the use of so avowedly a Catholic remedy as the "Jesuits' powder" was unthinkable, and a half-century elapsed before this prejudice and bigotry could be overcome, even in the interests of humanity.

Within historic times malaria has been driven from northern and central Europe, and from most of the United States, largely through the use of quinine. It has been widely accepted that malaria was an important contributing cause of the economic and cultural decline of ancient Greece and of the Roman Empire. One cannot help speculating what might have happened if the Greeks and Romans had possessed our specific remedy for malaria.

The eventual and general acceptance of quinine for the treatment of malarial fevers soon led to an enormously increased need for Cinchona bark. The original center of bark exploitation was the Loja region of southern Ecuador, but as the demand for quinine increased, the industry expanded northward into Colombia and southward into Peru and Bolivia, and reached fantastic proportions during the late eighteenth and early nineteenth centuries. Far from inducing measures of economy or conservation, indications of impending bark scarcity only resulted in still more intensive and destructive methods of bark harvesting as the competition became keener. The complete extirpation of trees in order to remove the root-bark caused the virtual disappearance of Cinchona species over wide areas. Finally, during the early nineteenth century, the wild-bark industry began to collapse as rapidly as it had expanded. Although prices increased, bark quality decreased, partly because of the exploitation of grades of progressively lower quality and partly because of adulteration with related but totally worthless barks. By the middle of the nineteenth century, the quinine shortage became so serious that the British and Dutch governments could no longer ignore it, since they were able to maintain their far-flung colonial empires throughout the malaria-infested tropics only with an abundant supply of quinine. In 1852 the Dutch sent Dr. J. C. Hasskarl to South America to collect seeds and plants of every available species of Cinchona, but the live plants which reached Java in 1854 later turned out to be almost worthless because of the very low alkaloid content of their bark. Nevertheless, seeds of better varieties were obtained from other sources, and after many vicissitudes Cinchona plantations were gradually established on a firm basis in Java. In 1859 the British government also acted to obtain Cinchona seeds and stocks of high quality with which to establish plantations in India. On the slopes of Mt. Chimborazo, in Ecuador, Richard Spruce obtained seeds and young plants of a superior race of *Cinchona succirubra*, whose bark was very rich in alkaloids but relatively poor in quinine. Spruce's materials, supplemented by further collections of seeds and seedlings made contemporaneously in other regions, reached India early in 1861 and formed the basis of an enormous plantation development

"TROPICAL" VEGETATION

THESE TREE FERNS AND AROIDS OCCUR AT 8,500 FEET ABOVE SEA LEVEL IN COLD, WET CINCHONA FORESTS.

which grew up there and in Ceylon. After a search lasting four years, Charles Ledger (see also SM, July 1943, pp. 17–32) received from a Bolivian Indian, in 1865, seeds of a form of *Cinchona calisaya* which turned out to be extraordinarily rich in quinine, and which had been a sort of trade secret among a particular group of Indians. Ledger sent these seeds to London, where a small part was sold to the Dutch government and the remainder forwarded to British planters in India. Unfortunately, the value of this variety of *Cinchona calisaya* was not properly recognized in India, and it gradually died out there. The Dutch were more fortunate in its cultivation, partly because they had longer experience and partly because the government subsidized their plantations. The trees arising from the Ledger seed were studied carefully by the Dutch, with results which astonished everyone concerned, since it could be seen very soon that this variety was unprecedentedly rich in quinine. As early as 1872 the bark of one tree was found to contain over 8 percent of quinine, and in 1876 a tree was discovered whose bark had produced over 13 percent of quinine. Already in 1877 the Dutch government plantations resolved to use for propagation material no trees with less than 10 percent of quinine in their bark! The high quality of the bark of Ledger's variety, which Moens named *Cinchona Ledgeriana,* was reflected at once by its high price in the market. Since even the best races of *C. succirubra* cultivated in India and Ceylon produced less than 5 percent of quinine sulfate and the average was perhaps 3 percent, they could not compete successfully with the Dutch barks. The Dutch government supplied private planters with seeds and cuttings of *Cinchona Ledgeriana* without charge, if they were prepared to devote their land to its cultivation. Under this policy Cinchona cultivation grew in a remarkably short time to such enormous proportions in Java that the price of a kilogram of quinine sulfate was reduced from \$100 to \$10 in the decade between 1880 and 1890. In the face of a price war among the Dutch planters themselves, who were dealing in a bark of superlative quality, the Cinchona planters of India and Ceylon either

VOLCANO OF TUNGURAHUA

THIS SNOW-CAPPED VOLCANO PROVIDES THE VILLAGE OF BAÑOS, ECUADOR, WITH HOT AND COLD WATER.

abandoned their low-grade plantations entirely or turned to the cultivation of tea. The Dutch thus inherited the whole Cinchona culture, but at a time when market prices were lower than the cost of production. About 1913 the Dutch bark producers united with the quinine manufacturers in order to form an organization which could fix prices at a level high enough to guarantee a profit to all concerned. The control of this organization was placed in the hands of a committee called the Kinabureau, which is often referred to as the "Dutch quinine monopoly," since at the beginning of the first world war it already controlled 95 percent of the world's quinine.

Just when the Dutch and the British were establishing plantations, the greatest demands were being placed upon the wild-bark industry. Our Civil War has been blamed for causing the last Cinchona "boom," since the desperate need for quinine by both armies raised the prices to a level at which the bark producers could again make a good profit. The end of the war precipitated the final collapse of the highly speculative and uncertain business of exploiting wild species of Cinchona. The production of mediocre but dependable grades of plantation bark by the British in Ceylon and India gave the real death-blow to the South American industry, just as the excellent Cinchona bark cultivated by the Dutch later put the plantations in India and Ceylon out of business. In a very short time, wild Cinchona barks from South America practically disappeared from the world market, although production for home consumption continued for some time on a small scale.

The invasion of the Dutch East Indies by the Japanese in the spring of 1942 not only cut off our supply of quinine but also committed us to a long war in which enormous quantities of this essential drug might be required. The task of finding sources of quinine was accepted almost at once by the newly-

created Board of Economic Warfare (now superseded by the Foreign Economic Administration). Naturally, the most practical solution of the problem was to revive the extinct Cinchona-bark industry in the several Andean republics which had provided the world with its quinine supply a century earlier. After lengthy negotiations, several of the republics granted to the Board of Economic Warfare exclusive buying rights in exchange for our guarantee to buy all bark above a certain minimum alkaloid content, to furnish technical aid to the bark harvesters and dealers, and to establish nurseries and plantations for future use. Because of the good will of all parties concerned, these agreements worked out reasonably well, and we were able to obtain much more bark in a much shorter time than had been anticipated —but I am getting ahead of my story.

Colombia was the first country to sign an agreement and since it is closest to the United States of the Cinchona-producing republics, it was the destination of the first procurement group, which left Washington in October, 1942. This first party consisted of six men: two foresters, two botanists, and a chemist, all under the supervision of a lawyer as chief of the mission. We were joined in Colombia by L. R. Holdridge, a forester and a competent field botanist, who came directly from his work in Haiti to supervise our survey work. The preponderance of field men indicates the importance justly placed on survey work. As originally planned in Washington, two field parties were to be organized, each one consisting of a botanist to find and identify the quinine-producing plants, and a forester to estimate the quantity of bark and to arrange for its exploitation. This plan was followed during our preliminary surveys for the first three months, but the departure of Mr. Holdridge and the need for expanding the field work made it necessary for the four field men to head separate survey parties. The extreme complexity of the Andean flora in general and the large numbers of species and varieties of Cinchona in particular made the usual methods of cruising and estimating employed in our temperate forest quite unsuitable. Consequently, as the program developed during the next couple of years, more and more

PRIMITIVE BARK DRIER
A SMALL SHELTER OF THIS SORT WILL DRY ABOUT THREE HUNDRED POUNDS OF FRESH BARK AT A TIME.

botanists were brought in for survey work, while the foresters in large part turned to other important work and made real contributions in the construction of trails and bark-driers, in the expediting of bark handling, in the solving of transportation problems, and in the establishment of Cinchona nurseries and plantations.

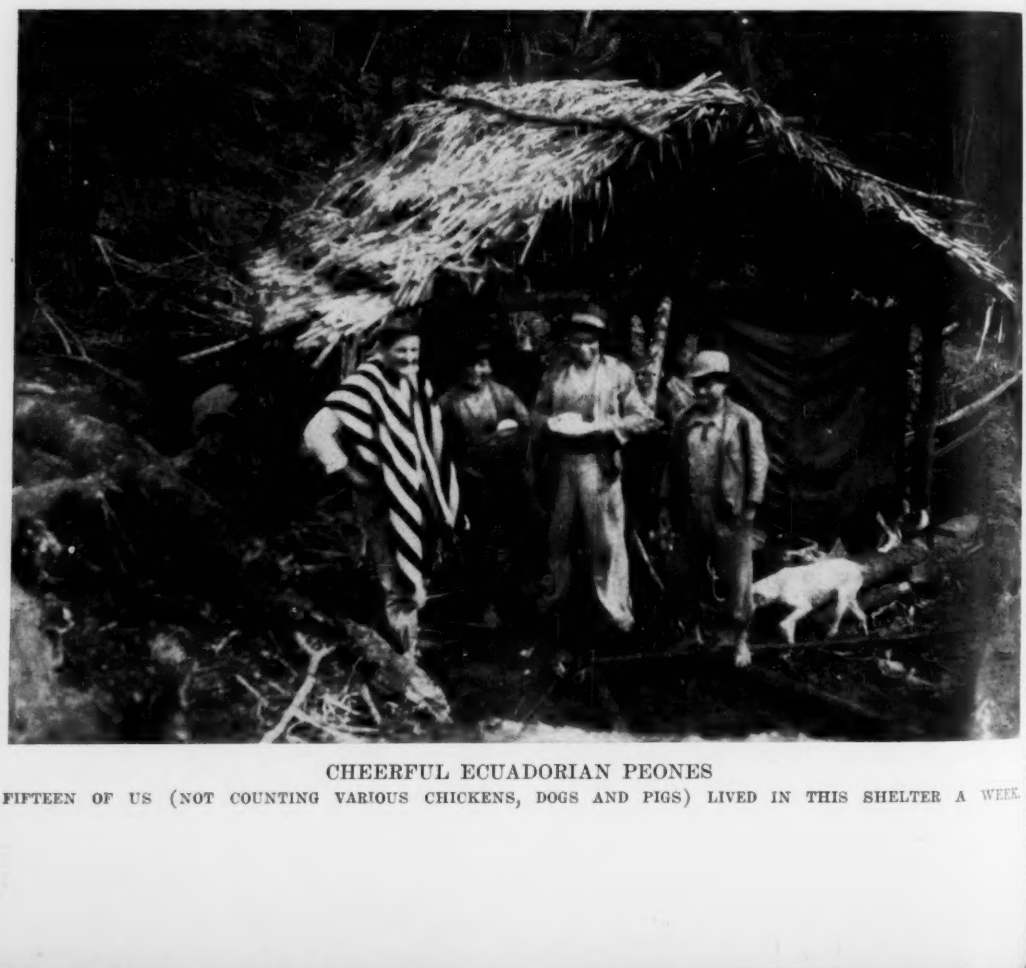
I have mentioned elsewhere the important contribution made to the Cinchona program by the chemists. The Cinchona mission laboratories established in Bogotá, Quito, Lima, and La Paz made possible the prompt analyses of field samples and lots to be purchased. In Cinchona "booms" of former centuries, analyses were made only after the shipment reached Europe, months after the bark had been bought and the proceeds spent. This situation led not only to fantastic speculation on good barks but to excessive traffic in worthless ones. Many barks which were sold at high prices turned out to be totally lacking in quinine, although perhaps rich in

cinchonine or cinchonidine. Through prompt analyses we were able to stop the harvest of poor barks and to encourage the production of good ones. Many species of Remijia, Ladenbergia, and other members of the Rubiaceae closely resemble Cinchona to the untrained eye, and our technical aid, both botanical and chemical, has saved much energy and many thousands of dollars which dealers would otherwise have "invested."

The published literature on all the aspects of Cinchona-bark production in South America is so extensive that a compilation of just the titles would probably fill a whole volume. The amount of unprinted folklore, legend, tradition, and popular belief among the people themselves is even more extensive. Since the ancient exploitations of Cinchona bark followed a very empirical system, under which any useful discovery was considered to be a trade secret, we could find few answers to the practical problems which confronted the survey parties. The only thing we were sure of was that a new and reasonably complete survey had to be made, and that all species and varieties of Cinchona and related genera must be searched for and tested as potential sources of quinine.

More than a dozen species of Cinchona occur in the Andes, and nearly all of them produce quinine or some alkaloid related to it. Some species produce alkaloids in such small amount that they are of no economic value at all, but only of botanical interest. In the field one may recognize Cinchona trees not only by their technical botanical features but also by the bitter taste of their bark. The different species and varieties differ greatly in their total content of alkaloids as well as in the percentage of each one. Each species of economic importance has so typical an alkaloid content that one may make his identification from the analyses of a bark sample without seeing a botanical specimen.

Linnaeus described the first species of Cinchona in 1753, calling it *Cinchona officinalis*. There are many varieties or races of this species, some of them without any



CHEERFUL ECUADORIAN PEONES

FIFTEEN OF US (NOT COUNTING VARIOUS CHICKENS, DOGS AND PIGS) LIVED IN THIS SHELTER A WEEK.

RELUCTANT MULES
THIS SUSPENSION BRIDGE OVER THE RÍO GUATIQUÍA, IN THE EASTERN ANDES OF COLOMBIA, IS TYPICAL.

quinine at all, and others, which have been called *C. calisaya*, the richest in quinine of all wild barks. The alkaloid most commonly associated with quinine in the bark of *Cinchona officinalis* is cinchonidine, although the *C. calisaya* types in Bolivia also produce considerable quinidine, and a much larger proportion of quinine than other alkaloids. *Cinchona officinalis*, in one form or another, is widely distributed from western Venezuela through the eastern Andes of Colombia and Ecuador into Peru and Bolivia.

The commonest species of Cinchona everywhere is *C. pubescens*, which is characterized by its large leaves, thick bark, and rapid growth. Unfortunately, its bark is commonly low in alkaloids and may lack quinine altogether. Nevertheless, there are some local races, called *C. succirubra*, which produce high alkaloid concentrations, and it was a race of this sort which was introduced into India from Ecuador in 1861. The bark of *Cinchona pubescens* usually contains much cinchonine and may produce no other alkaloid at all. This is the most widely distributed species of Cinchona, which occurs in Venezuela, in all three ranges of the Colombian Andes, in both ranges of Ecuador, and very widely in Peru and Bolivia. Not many years ago, a few trees were found in northernmost Panama and along the Costa Rican frontier. This is the only species of Cinchona native to North America.

One of the most interesting species has been *Cinchona pitayensis*, which was first discovered on the slopes of the Nevado del Huila in south-central Colombia, not far from Popayán. The bark of this species is not only unusually rich in quinine for a wild species, but the quinine is extracted unusually easily. However, this species was considered to be very rare by the early bark dealers, and it remained almost unknown to botanists. One of the real contributions of our survey work in Colombia was the rediscovery of *Cinchona pitayensis* in rather substantial quantities, and I shall always feel that my primary service to the program was the first discovery of this species in Ecuador. It seems incredible that the species of Cin-

IN THE CINCHONA FOREST
THE WESTERN SLOPES OF THE ECUADORIAN ANDES ARE COVERED WITH DENSE AND EXTENSIVE FORESTS.

chona with consistently the highest-yielding bark should have remained unknown in Ecuador until the summer of 1943, but the tradition among Ecuadorian bark dealers that the better barks occur only at lower levels seems to have kept them from exploitations at high altitudes. Since the best "red" barks, from *Cinchona pubescens*, occur at about 4,000 feet above sea-level, it is no wonder that the dealers were skeptical when we pointed out to them a better Cinchona between 9,000 and 10,000 feet. This species has now been followed into Ecuador more than a hundred miles south from the Colombian frontier, and at last report may occur still farther south. The details of its discovery and some of its more important botanical features have been outlined elsewhere.

One of our biggest surprises was the discovery of a race of *Remijia pedunculata* in northern Colombia whose bark produced as much as 3 percent of quinine, with hardly any other alkaloid. This plant is not a Cinchona at all, although fairly closely related, but illustrates the importance of our method of studying all Rubiaceae.

Many profound treatises have been devoted to the classification of the various types of Cinchona barks, and dozens of different sorts were distinguished on the basis of color, surface, grain, inrolling or outrolling, etc. Unfortunately, the botanical source of the bark under consideration was generally ignored, and several distinct types in the old classification of barks might easily come from the same tree, depending on the part of the tree and the method of preparation. The thick bark from the base of the tree used to be dried in large, flat slabs, whereas the thin bark from small twigs and roots was dried in tightly-rolled tubes or "quills." The bark from the base of the tree is apt to be dark and rough, but the upper bark is often smooth, whitened with lichens, and shows transverse fissures and cracks. Our interest was not to distinguish all the ancient types of barks but simply to recognize the species from which the bark had come. One can develop the ability to distinguish the barks rather easily, especially if he has been trained in the discipline of systematic botany and its fine discriminations. The easiest

TYPICAL ANDEAN SHELTER

THIS SHELTER, TAMBO JUCAL, IS DITCHED TO KEEP LIVESTOCK AND OTHER ANIMALS FROM WANDERING IN.

bark to distinguish is from *Cinchona pubescens,* because it tends to form rather thick, flattened chips with an orange color. The chips are not inrolled, but rather tend to turn back or out at the ends. Perhaps the most constant feature is the torn and interwoven appearance of the fibers which were apparently distorted when the bark was stripped from the tree. The bark of *Cinchona officinalis* and its varieties is to be recognized by its darker, clearer red color, the tendency of the bark pieces to inroll strongly, and the parallel, undistorted appearance of the fibers which were next to the wood. *Cinchona pitayensis* has a rather yellow bark which resembles that of *C. officinalis* except that it rolls inward much more tightly, and the cuts at either end swell so that they are almost as thick as the bark where not cut. These two species also produce white upper bark with the characteristic transverse fissures, a character lacking in the bark of *C. pubescens.* Bark of all species of Cinchona shows needle-like fibers at the broken ends, to a greater or less degree. This character is especially useful to distinguish Cinchona barks from the bark of *Remijia pedunculata,* which may produce substantial quantities of quinine in certain areas. Remijia bark breaks with a brittle, glasslike quality, which serves to identify it.

The business of adulterating quinine-producing barks with the bark from other trees is a standard part of an old and not particularly honorable profession. It was always amusing to see the surprised expression on the face of a dealer when the supposedly innocent—or at least ignorant—field man was able to detect the admixture at once and reject the lot. A whole book could be written on the subject of bark identification, its folklore and anecdotes.

The forests which contain Cinchona are usually not at all easily accessible, because as soon as a road opens a new valley to the public, the forest soon disappears before the settlers' axes and Cinchona trees generally fall unrecognized. Even though the cut-over land be abandoned later, the better species of Cinchona seem to be extremely slow in returning. The outstanding exception is *Cinchona pubescens,* which will often repopulate an old field within a few years. It is unfortunate that this species has so little value, since it grows extremely rapidly in most habitats and under some conditions may become almost a weed. Its main usefulness seems to be as grafting stock in nursery work,

CINCHONA PUBESCENS

THIS COMMON ANDEAN TREE MAY REACH A DIAMETER OF THREE FEET AND PRODUCE NEARLY A TON OF BARK.

ECUADORIAN BARK–CARRIERS

STRONG BACKS ARE NEEDED ON STEEP, MUDDY TRAILS WHICH OTHER BEASTS OF BURDEN CANNOT NEGOTIATE.

for giving good root-systems to weaker species. Along the railroad not far north of Popayán, one may see many trees from the train window, and dozens of trees occur along the automobile road between Quito and Santo Domingo de los Colorados. In both places, however, the bark is almost worthless. *Cinchona officinalis* and *C. pitayensis* are much more sensitive to change and have retreated farther and farther before the inroads of settlers and bark harvesters. It is very rarely that these species are to be found near a road, and then only because the country is too rugged for cultivation and the trees have not been recognized yet. Ordinarily, one may depend on a trip of from one day to two weeks by horse or on foot in order to reach Cinchona-producing forests, which are always on steep mountainsides in rainy regions. As moist air from the hot tropical lowlands rises along the slopes of the Andes, it cools and precipitates its moisture in rather definite bands. As one progresses from sea-level to the upper limit of tree-growth, at about 11,000 feet above sea-level, he will pass through several rain-belts, which are easily recognized by the much more luxuriant growth of plants, the mud, and the low-hanging clouds. Cinchona trees are restricted to wet forests, which are usually covered by clouds at night, and apparently cannot withstand a prolonged dry season. The standard joke of the field men in Ecuador was that during the dry season in the Cinchona forests, it rained only in the afternoons. An annual rainfall of 150 to more than 200 inches is not unusual and must be taken into serious consideration when planning any work of exploration or exploitation.

The Cinchona forests of Ecuador, especially in the eastern Andes, are so remote and inaccessible that a survey party must plan on making its own trails and packing all its equipment on the backs of men. On a survey trip lasting between two weeks and a month, each man will eat a large proportion of all the food he can carry, and in a general way one has to estimate that every two men need another man to carry food for them. Since several men are needed for cutting

trails and several others for carrying baggage, especially tents for protection against the continual rains, parties of 10 to 15 men are not uncommon. Fortunately, the diet preferred by the men is a very simple one and compact to carry, since it consists of barley meal, coarse brown sugar in large cakes, parched corn, rice, beans, lard, and coffee. I ate this same diet, not from preference, but simply because it was easier than carrying extra food. The only exception was that I carried enough canned meat to have some at least every other day. An occasional settlement or homestead in the wilderness would provide us with some eggs or rarely a muscular chicken. The staple meat in the backwoods of highland Ecuador is the guinea pig, which is delicious indeed after one has gone for several weeks on a diet light in protein. I will never forget the banquet in the tiny settlement of La Bonita when we were able to buy a whole hog, which furnished much-needed protein to the survey party and a real celebration for the isolated village. When the men become really discouraged, the gift to them of cheap cigarettes works wonders. Yet we always had to buy the cigarettes for the men out of our own pockets because the Cinchona mission auditor could not be convinced that this was a legitimate expense—even though he would never have been able to smoke them!

One of the surprising features of the Cinchona field-work in South America is that we suffered much more from cold than from heat although we were always within 15 degrees of the equator. Those of us who were engaged in exploration for *Cinchona pitayensis* between 8000 and 10,000 feet above sea-level often had to camp and travel in the Andean *páramos* above tree-line, where cold nights are the rule and snow-storms not infrequent. The rate of radiation of body heat is doubled at high altitudes, and one used to sea-level always has the sensation of being cold, especially if he is wet. Nevertheless, it seems ridiculous to suffer from cold when the temperature is no lower than 50° F. and he is sitting practically on the equator!

Our surveys were made under widely varying circumstances. At times they were sponsored by some land-owner who hoped that his forests might consist entirely of Cinchona trees. In such cases, we could depend on certain facilities in return for our technical advice; that is, the owner was glad to furnish us some transportation, to lend us guides and machete-men, and to allow us to use what houses might be on his property. Very few owners found it possible to accompany the survey personally, however. At the other extreme, we surveyed many large areas which had never been purchased or homesteaded. Much of the land of the Oriente of Ecuador is wild and unsettled—*terreno baldío*—which may be had for the asking from the government, under much the same rules as our own western homesteads. These lands are unsettled because of their lack of roads, their inhospitable climate, and their distance from centers of population. Here we sweat and struggled for weeks at a time, cutting trails, crossing flooded rivers, trying to keep the discouraged cargo-bearers from skipping out and leaving us and our baggage on the headwaters of some unknown river, far from civilization.

BRIDGE OF SIGHS

IN DAILY USE, THIS NARROW BRIDGE IS OVER THE DEEP GORGE OF THE PASTAZA AT BAÑOS, ECUADOR.

TIMBER LINE IN ECUADOR
THE FOREST AND THE PÁRAMO MEET EACH OTHER AT 11,500 FEET ABOVE SEA LEVEL IN CARCHI PROVINCE.

Although one square mile of virgin forest on the steep slopes of the Andes in Colombia, Ecuador, Peru, or Bolivia may have several hundred species of trees, Cinchona trees are not as difficult to find as one might expect. Fortunately, each species has a certain fixed and definite altitude preference or limitation, so that with an altimeter one can stay quite easily within the altitudinal range of the species for which he is searching. Furthermore, Cinchona trees tend to be grouped together, not in pure stands but in associations of 5–50 trees, called *manchas,* in reasonably close proximity, so that one tree may be seen from another. Also, one who is interested in plants may fix his attention on them so intensely that he will see only those which he wishes to see. My survey technique was to make myself aware only of members of the Rubiaceae, the plant family to which Cinchona belongs. In this way no species of Cinchona could be missed, and many interesting Cinchona relatives were automatically discovered for testing.

The estimates of the quantity of bark which the survey parties made were not only interesting but often also highly entertaining. Instead of the extremely accurate and scientific techniques available to a forester estimating board feet of lumber in a pine forest in the United States, we had no technique except shrewd guesses based on our past experience with the same species or variety under more or less similar conditions. We came to know fairly exactly those data which could be measured; for example, we knew the percentage of water in the bark of each sort of Cinchona. More than 80 percent of the bark of some species is water, in other species the water content may be as low as 65 percent. We knew the thickness of bark and rather accurately how it differed in trees of different ages and diameters. We even made tables based on a formula derived from the fact that the surface of a cylinder may be calculated from the diameter—from which could be tabulated the bark yield of a tree of any size. Unhappily for the scientific method, there are so many intangibles in the brand-new science of calculating bark-yield that the actual yield could be estimated just about as closely by an intelligent man with a good deal of experience. It is much easier to make an estimate on the basis that each three trees of a certain population will yield a hundred pounds of bark than to reach more or less the same conclusion by spending a half hour in mathematical operations. It was more important to see that the branches down to three inches in diameter were skinned of their bark than to worry too much about formulas, since if bark is left on the tree even the best-planned formula goes astray. A practical job of this sort is useful experience to any of us who have leaned rather heavily on theoretical evidence!

As soon as a tree is felled, either by a heavy machete or with one of the straight-handled, broad-bitted axes which our Latin brothers prefer, one or two men set themselves at once to the task of stripping off the bark. In some varieties the bark is very firmly attached to the wood, so that it comes off in the form of chips or untidy fragments. In other varieties often called *concha* (shell) the bark separates very easily from the wood, so that the men have competitions to see who can bring in the largest piece. I have seen a flat piece of bark proudly exhibited which was five feet long and three feet wide. Usually, however, the work is deadly serious and with strong economic limitations. If the price is low, only the heavier, more easily removed bark is harvested; if the price is high, then the smaller branches may be stripped. The usual tool is the ubiquitous machete, which may be specially ground for the job. In the region of Loja and Cuenca, where bark-harvesting

has been going on for two centuries, a special knife has been developed for separating the bark from the wood, and men from this region are very expert in their knowledge of barks and how to handle them.

After our first surveys, we came to the conclusion that for most efficient exploitation the trees should be cut down. At first flush, this might sound like an extravagant waste of natural resources and a violation of all laws of conservation which we should encourage in ourselves and other nations—and we were accused of all these things. However, in the long run, we always managed to convince even our most determined opponents of the advisability of cutting down the Cinchona trees. One of the most telling arguments is the fact that the stumps of cut trees have the ability to produce sprouts almost at once, and that in the course of a few years each cut tree becomes a whole cluster of new trunks. In this way, if the rest of the forest is left undisturbed, the natural resource will regenerate itself more or less automatically. On the other hand, trees which are stripped of part of their bark while standing are apt to die, and trees which die while standing do not sprout. It is a hopeless task to argue with the bark stripper that he must take bark from only one-half of a standing tree. To him, bark represents money or food or something he wants, and to leave bark on the trees is to him as distasteful as it is for us to have him take it all. As a special concession, occasionally, a man would agree to take only half the bark from a tree, but then we would find out that his partner—the men usually work in pairs—was harvesting the other side, so that neither man was taking more than half the bark from the trunk! The important point of all this is that girdled trees which die do not regenerate themselves and have no further value. Furthermore, a standing tree can be stripped of only a quarter to a half of the bark which can be gotten from a felled tree, and a much greater efficiency is reached in bark production by cutting the trees. The most important point to be made, and the one which appeals most to the logical Latin economists, is that almost 100 percent of the wild Cinchona bark now being harvested in the Andean forests was worthless in the world markets before the war, and presumably will be worthless again after the war, just as soon as plantation bark containing from 7 to 10 percent of quinine sulfate appears on the market. In other words, here was the chance to reap a harvest, to sell a commodity at a good price which under normal conditions could not be sold at all in the world market. So it was not difficult to prove that a law prohibiting cutting of the trees—even if it were observed—would result in an economic loss to the country which passed the law.

In the beginning, one of the great gaps in our knowledge was how to dry bark most efficiently, with least loss of total alkaloid or the transformation of quinine to other and less valuable alkaloids. There is a wide-

CENTRAL BARK DRIER

WITH A CAPACITY OF SEVERAL TONS OF FRESH BARK THIS STRUCTURE WAS PLANNED AS A BUYING CENTER.

spread superstition among the bark harvesters and dealers of every country which produces Cinchona that sun-drying is injurious to the alkaloid content. We soon discovered that the greatest source of loss of alkaloids was fermentation, or "heating," of bark which had been piled up wet and allowed to stand. Sun-drying was found to have no injurious effect; in fact it is distinctly beneficial since it discourages fungus growth. Someone, in the early days of Cinchona plantations, remarked in print that 80° C. was the critical temperature for artificial drying, above which alkaloids would be destroyed. The basis for this recommendation may have been a careful, scientific study, but I doubt it. It is more likely to be somebody's opinion

which just happened to get into print and has been copied painstakingly by everyone writing on the subject since. Anyhow, it is manifestly absurd to tell a group of Indians not to let their drying bark reach a temperature above 80° C., or even to furnish them with thermometers. Where bark is to be dried in small lots near its origin it is simply spread out on bamboo racks or platforms under thatched roofs, and open fires lighted underneath them. Imagine trying to maintain scientific precision under such conditions! By trial and error methods and the use of a chemical thermometer, we finally arrived at a method of controlling the heat. We found that if the racks were 120 centimeters (about four feet) above the ground, even a bright bonfire beneath would do no apparent damage. When heat from the fire was safe for the bark, we found that we could place our hands palm up on the bottom of the racks over the bonfires without pain. Even the most primitive dweller of the primeval Andean forest can understand directions of this sort. We found that one square meter of rack can accommodate a hundredweight of wet bark and that fires at intervals of two meters under a rack two meters wide give satisfactory results. With practical information of this sort, we could advise a dealer on the size of the drier he must construct to handle the bark available to him, in order that no bark would ferment on standing and yet so that he would not overexpand. If an area was especially rich in Cinchona or if local conditions were such, through lack of materials or through excessive rainfall, that small driers could not be constructed in the forest, then a more efficient drier of greater capacity had to be built. It is obvious that when open fires are maintained under a rack covered with wet bark, much of the heat will escape at the sides and the process will take a longer time. Yet the investment of building a larger drier, in which the heat is directed through the bark by having the sides boarded up or covered with sticks and mud, can hardly be justified in a small-scale business. In the Javanese plantations, where bark can be brought in from the same trees year after year in predictable quantities, the driers are very complicated and expensive machines which dry the bark under controlled conditions. In the exploitation of wild barks, however, the cost of an expensive drier might make the difference between profit and loss to a small dealer. In the Andes one not rarely finds deep, dry valleys which are rain-shadow deserts in the midst of areas with excessive rainfall. In several localities in Ecuador and Colombia it was possible to carry the wet bark several miles and dry it in the open air with a shelter or sometimes without any cover. In the rainy zone it is hopeless to dry bark without artificial heat. I have seen bark kept under a shelter, not exposed to rain but only to the air, which had not become completely dry at the end of three months. In the same region bark which had been painstakingly exposed to every bit of available sunshine for a month was not really dry.

After the bark is dried it is packed for shipment in jute bags which will hold 100 pounds. The dry bark, which has lost approximately 70 percent of its weight, is tamped tightly into the bags, yet because of its bulk a hudredweight of Cinchona bark is twice as large as a hundred-pound sack of sugar. The bulk of bark always creates problems in hauling and storing, yet several thousand tons of Cinchona bark were harvested and shipped during the last few years.

In Ecuador the bark was harvested on the outer flanks of the great Andean chain and always had to be brought over the top of either the eastern or western range in order to reach highways or railroads. Many of the original trails through the mountains were in such bad condition that they had to be extensively repaired or new roads built into bark-producing regions. Trails built for occasional travel broke down soon when subjected to everyday use by hundreds of men, horses, mules, oxen, or llamas carrying food and supplies in and Cinchona bark out. As soon as the bark reached a highway most difficulties were over, in spite of shortage of gasoline and tires, and delays of every sort. Sooner or later, by truck, train, or river boat, the bark reached a seaport—Callao, Guayaquil, Buenaventura, or Barranquilla—where it could be loaded onto ships bound for American processing plants, thus making all our work worthwhile.

"INTELLECTUAL" VERSUS "PHYSICAL" PEAK PERFORMANCE: THE AGE FACTOR

By HARVEY C. LEHMAN

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IF THE chronological ages at which athletes achieve their peak performances are to be ascertained successfully, the following facts need to be taken into account: (1) The more vigorous skills, such as boxing, football, ice hockey, and tennis, tend to deteriorate relatively early, the median ages and the peaks of performance age-curves for each of these behaviors occurring prior to age 30. Other skills, such as rifle and pistol shooting, bowling, duck-pin bowling, and billiards, which require less explosive outbursts of speed and energy for their successful performance, deteriorate more slowly. (2) At the time of exhibiting their best performances, certain kinds of more recently born athletes have been somewhat older than were their predecessors within the same field of sport. Thus, the earliest pitching and batting annual champions of the two major American baseball leagues were somewhat younger than were the major league annual champions during the decades just prior to the outbreak of World War II.

Possibly, with the passing of time and the increase of public interest, professional baseball has become so profitable financially that the stellar performer tends to participate therein as long as he is able. This age increase may also be due in part to the fact that the more recently born athletes have learned better how to preserve and maintain their physical fitness. Be that as it may, when the ages of seven groups of earlier-born athletic champions were compared with the ages of seven groups of those more recently born, the field of sport being kept constant in each comparison, the later-born exhibited both older mean ages and also smaller standard deviations from their mean ages in six of the seven comparisons. This finding could not be a result of conditions brought about by World War II, because all age data for athletes presented herein were obtained prior to the outbreak of World War II.

Detailed comparison of the chronological ages of greatest productivity in the several sciences reveals, likewise, a number of complicating factors. For example, men born from about 1775 to 1850 did their best creative work at somewhat younger chronological ages than did men who were born prior to 1775. Thus, in 12 of 15 comparisons that were made, the contributions of the more recent era were made at somewhat younger average ages.[1] It seems clear, therefore, that if a valid comparison is to be made of the ages of greatest productivity in the several sciences the century of birth of the several kinds of creative thinkers must be kept constant. In order to accomplish this goal the creative works of individuals who were born more than about two centuries ago have been omitted from the present study whenever such omission resulted in a significant difference in the average age of achievement.

Still another complicating factor was the finding that quality of output and quantity of output are imperfectly correlated. Therefore, no very accurate comparison of the ages of greatest proficiency in the several fields of science can be made unless the contributions under consideration are first equated upon the basis of their quality or merit.[2]

One other explanatory remark should perhaps be made. In Table 1 the number of creative achievements within each separate field of endeavor is purposely kept small because, when the number of assembled cases is large, less select creative works are likely to be included in any given list. When less select works are included, the average age of the performers is likely to shift either upward or downward, but more often the mean age moves upward. Hence, if care is not taken to avoid it, when the ages of various kinds of creative thinkers at time of stellar performance are found to differ, those age differences may be due to a difference in the quality of the performance rather than

TABLE 1
CHRONOLOGICAL AGES AT WHICH MEN HAVE MADE NOTABLE CONTRIBUTIONS TO VARIOUS SCIENCES, MATHEMATICS AND INVENTION

Type of endeavor	Number of individuals	Number of works	Peak years	Median chronological age
Practical inventions	86	135	30–34	33.36
Mathematics	27	42	20–24	34.00
Chemistry	47	52	26–30	34.00
Physics	44	80	30–34	34.60
Introduction or discovery of remedial drugs	44	73	30–34	34.70
Anatomy	70	86	35–39	35.71
Bacteriology	30	39	35–39	36.50
Pathology	84	107	35–39	39.00
Physiology	54	59	35–39	39.33
Classical descriptions of disease	52	77	30–34	40.17
Botany	50	144	30–34	40.33
Geology	65	99	35–39	41.08
Surgery	76	103	35–39	41.75
Entomology	86	86	35–39	42.00
Psychology	50	85	35–39	42.58
Astronomy	68	92	40–44	44.20

to the type of endeavor *per se*. Since the present study is concerned with achievement of the very highest merit, rather than with mere quantity of output, a studied attempt has been made to include herein only very select, and hence of necessity, small numbers of achievements within each separate field of endeavor. But this precaution introduces a new hazard, since small numbers of cases make for large probable errors in the means.

Although the present writer has tried to meet each of the above-mentioned difficulties as best he could, this could be done only approximately. For example, the problem of obtaining equally select creative works from within diverse fields of science, some of which fields obviously are much more backward than others, could not be solved in a perfect manner. Therefore, in studying Table 1 the reader should realize that for performances which have similar averages the differences in the median ages at time of achieving may not be significant. For behaviors listed near the top, as compared with those listed near the bottom of the table, the median age differences may be of genuine significance. But one should not be too certain that even this latter assertion is wholly valid. Therefore, in the construction of Figure 1 the data for the several kinds of creative work listed in Table 1 have been treated collectively.

Ages of Maximum Proficiency in Science, Mathematics, and Practical Invention. Figure 1 and Table 1 present the chronological ages at which approximately 933 deceased creative thinkers either made or first announced 1,059 outstanding discoveries in science, mathematics, and practical invention. The word "approximately" or "about" is used here and hereinafter in referring to the number of individual contributors because some individuals contributed to more than one field of endeavor. If it may be assumed that the present writer has succeeded in his

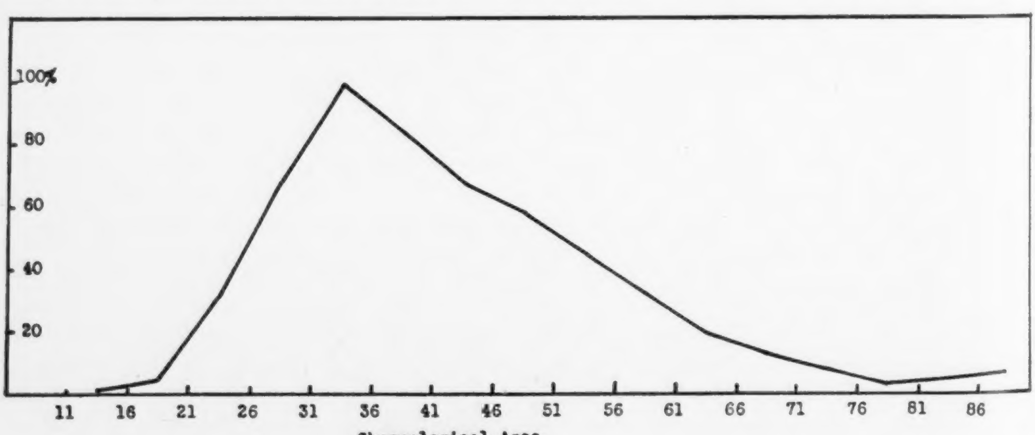

FIG. 1. AGE VERSUS PRODUCTION IN SCIENCE, MATHEMATICS, AND INVENTION
REPRESENTING 1,059 SUPERIOR CONTRIBUTIONS BY 933 INDIVIDUALS NOW DECEASED (OR 1.13 WORKS EACH).

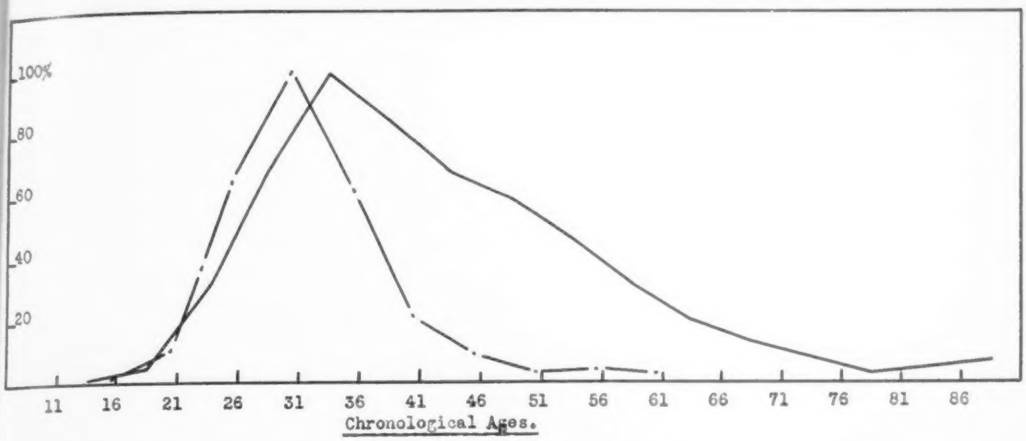

FIG. 2. AGE VERSUS OUTPUT IN SCIENCE AND PROFICIENCY IN CERTAIN SKILLS
Solid line, SAME AS FIGURE 1. *Broken line,* 1,175 CHAMPIONSHIPS IN 17 CLASSES LISTED IN TABLE 2.

attempt to include a good sample of man's most notable discoveries and inventions in Figure 1, this figure may perhaps be regarded as a generalized age-curve which shows the rise and fall of man's best (or almost his best) output in the fields indicated.

In the construction of each of the age-curves that accompany this article the several graphs were reduced to a comparable basis, and proper allowance was made for the mortality rate, by a method that has been described previously.[1] If, regardless of the number of workers that remained alive, the 50-year-olds had contributed at the same average rate as did the 33-year-olds, the curve in Figure 1 would remain as high at the 50-year-old age level as it is at the 33-year-old level. Actually, the curve exhibits a very noticeable descent beyond age 33, with no secondary peak at any of the older age levels. Figure 1 thus reveals that in proportion to their numbers men have made their outstanding contributions most frequently to the indicated fields during their early thirties.

When 5-year age intervals are used it is customary to employ age intervals 10–14, 15–19, etc. Detailed study of the tabulated data revealed clearly that the most productive 5-year period was that from ages 31 to 35, inclusive. In order to set forth this finding most vividly, the conventional age intervals were therefore abandoned in the construction of Figure 1, and those intervals which best fit the assembled data were used.

Athletic Success versus Scientific Discovery. In order to reveal its similarity to certain other age-curves, Figure 1 is reproduced in Figures 2 to 6 inclusive and also in Figure 11. Thus, the solid line of Figure 2 is identical with Figure 1. The broken line of Figure 2 sets forth, on the other hand, the ages at which the 1,175 important athletic championships listed in Table 2 were won.

When age data were assembled separately for only the best, or almost the best, of those relatively less vigorous championship performances in which precision of movement and nicety of neuromuscular coordination seem most likely to be the decisive factors in winning, i.e., for golf, billiards, rifle and pistol shooting, bowling, and duck-pin bowling, and when data for only the last-born 50 percent of the champion performers in these fields were included, the broken line of Figure 3 was obtained. For constructing this broken line of Figure 3 age data for 577 championship performances were employed. But, since some individuals held their championships for more than a single year, the number of different performers is somewhat less than is the number of performances.

Figure 3 discloses an important fact that would not be known if only the mean and the median ages were available. The difference in the mean ages of the scientists and of the athletes pictured in Figure 3, at the time of their stellar performances, is 7.58 years; the median age difference is 6.08 years. But

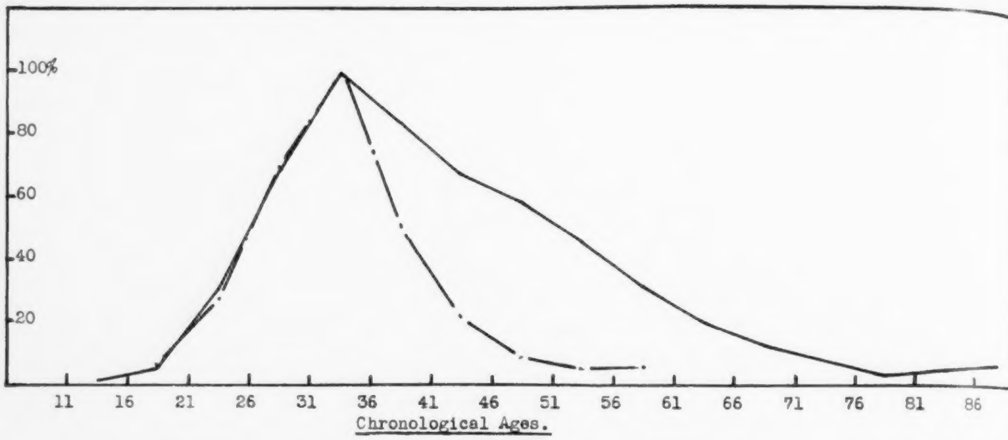

FIG. 3. AGE VERSUS OUTPUT IN SCIENCE AND PROFICIENCY IN CERTAIN SKILLS
Solid line, SAME AS FIG. 1. *Broken line*, 577 CHAMPIONSHIPS AT GOLF, BILLIARDS, RIFLE AND PISTOL SHOOTING, BOWLING, AND DUCK-PIN BOWLING—SKILLS OF THE NICEST NEUROMUSCULAR COORDINATION.

these differences are due almost entirely to the different rates at which the two curves of Figure 3 descend from their peaks. This difference is doubtless due in part to the fact that no time lag intervened between the winning of the athletic championships and the recognition that was received therefor. As regards the creative works, on the other hand, a long period of time must often have elapsed between the birth of the great idea and the

TABLE 2

AGES AT WHICH INDIVIDUALS HAVE EXHIBITED PEAK PROFICIENCY AT "PHYSICAL" SKILLS

Number of cases	Type of skill	Median chronological age	Mean chronological age	Peak years (mode)
89	U.S.A. outdoor tennis champions	26.35	27.12	22–26
49	Runs batted in: Annual champions of the two major baseball leagues	27.10	27.97	25–29
64	U.S.A. indoor tennis champions	28.00	27.45	25–29
77	World champion heavy-weight pugilists	29.19	29.51	26–30
31	Base stealers: Annual champions of the two major baseball leagues	29.21	28.85	26–30
82	Indianapolis-Speedway racers and national auto-racing champions	29.56	30.18	27–30
53	Best hitters: Annual champions of the two major baseball leagues	29.70	29.56	27–31
51	Best pitchers: Annual champions of the two major baseball leagues	30.10	30.03	28–32
127	Open golf champions of England and of the U.S.A.	30.72	31.29	28–32
84	National individual rifle-shooting champions	31.33	31.45	32–34
103	State corn-husking champions of the U.S.A.	31.50	30.66	28–31
47	World, national, and state pistol-shooting champions	31.90	30.63	31–34
58	National amateur bowling champions	32.33	32.78	30–34
91	National amateur duck-pin bowling champions	32.35	32.19	30–34
53	Professional golf champions of England and of the U.S.A.	32.44	32.14	29–33
42	World record-breakers at billiards	35.00	35.67	30–34
74	World champion billiardists	35.75	34.38	31–35

collection of supporting evidence, verification of the findings, etc.

Scientific Discovery versus Starring in the Movies. The broken line of Figure 4 sets forth the successive chronological ages at which movie actors (males only) have been found to be "best money-makers." As here used the term "best money-makers" refers to those actors who were the leading box-office favorites during the years 1915 to 1939, inclusive. The sources from which age data regarding the best money-making actors were obtained, and some observations regarding the actors, are published elsewhere.[3] The broken line of Figure 4 presents age data for 1,770 best money-making years but not for that number of different individuals, since the same actor is often listed among the best money-makers for several successive years.

Although the solid line of Figure 1 is plotted again in Figure 4 by use of age intervals 11–15, 16–20, etc., those numerals which best fit the curve for the money-making actors have been used along the baseline of Figure 4. This procedure, which has been repeated in Figures 5 and 6, explains why the peak of the curve for scientific achievements seems to be slightly out of line (too far to the left) in Figures 4, 5, and 6.

The slight difference in the shapes of the two curves of Figure 4 should be interpreted in light of the fact that a more select list of only 131 best money-makers yielded a curve which descends more rapidly than does either of the curves of Figure 4. In view of the fact that the shapes of all performance age-curves are in part a function of quality of execution, one is led to wonder just how well the two curves of Figure 4 would coincide if a perfect technique were available for equating the two behaviors shown therein upon the basis of their rarity or difficulty of performance.

Contributions to Science, Philosophy, and Music. In Figure 5 the solid line which sets forth man's most creative years in science, mathematics, and practical invention is plotted by 10-year instead of by 5-year intervals. This makes it more directly comparable with the two other curves which appear in Figure 5.

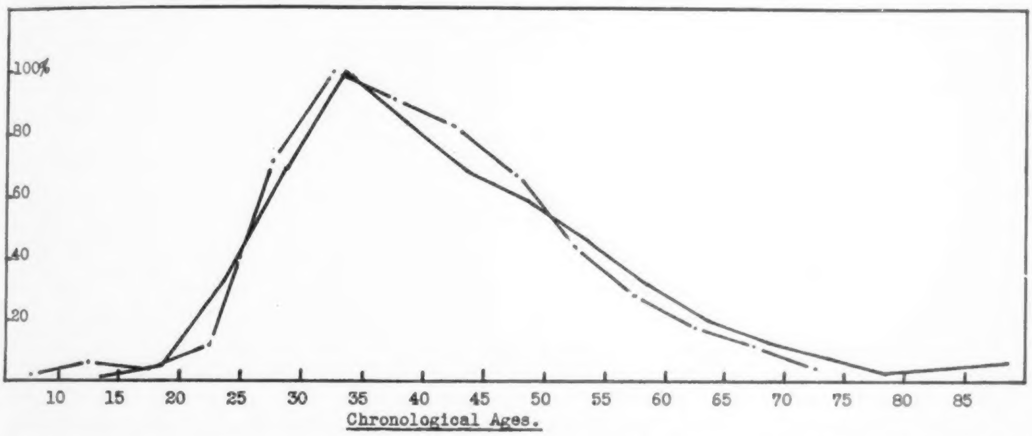

FIG. 4. AGE VERSUS OUTPUT IN SCIENCE AND BEST MONEY-MAKING MOVIE-ACTING
Solid line, SAME AS FIG. 1. *Broken line,* 1,770 YEARS AT WHICH MOVIE ACTORS LED AT THE BOX OFFICE.

The dash line of Figure 5 presents the ages at which each of 97 noted philosophers, born from 1763 to 1850, either wrote or first published his one most widely quoted treatise. The 97 philosophers are the most recently born 50 percent of a group studied by the present writer. The reason for excluding age data for the earlier-born 50 percent of the philosophers has already been given. And the methods by which both the philosophers and the one most notable treatise of each were identified have been described previously.[4] When 5-year intervals were used, the resultant age-curve for the 97 philosophical contributions was found to be rather

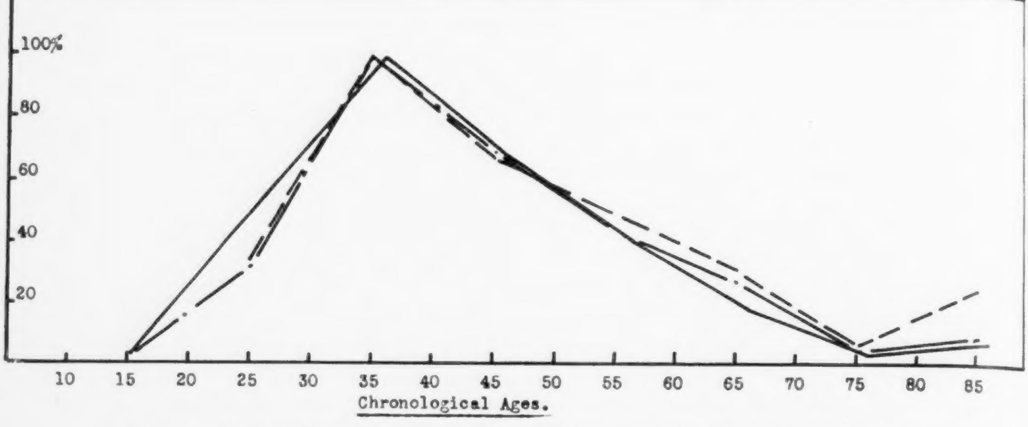

FIG. 5. AGE VERSUS OUTPUT IN SCIENCE, MUSIC, AND PHILOSOPHY
Solid line, SAME AS FIG. 1. *Broken line,* OUTSTANDING TREATISES BY 97 NOTED PHILOSOPHERS (1763-1850). *Dotted line,* 557 SELECT MUSICAL COMPOSITIONS BY APPROXIMATELY 382 COMPOSERS NOW DECEASED.

irregular. Therefore, the curve for the philosophical contributions was smoothed in Figure 5 by taking 10 years, instead of 5 years, as the unit. This procedure increases the number of cases within each class interval. It thus eliminates irregularities and sets forth more clearly the general trend of the age differences.

The broken line of Figure 5 is a composite curve which sets forth man's most creative years in seven different forms of musical composition—a total of 557 select compositions by approximately 382 deceased composers. The sources from which data regarding the musical compositions were obtained are given elsewhere.[5] All three curves of Figure 5 differ only slightly. For the three statistical distributions shown in Figure 5 the mean age differences are small and of doubtful significance.

Although it is popularly believed that teenage contributors have been much more numerous in music than in other fields of endeavor, the similarity of the three curves of Figure 5 suggests that reconsideration of the foregoing hypothesis may be in order. Inspection of numerous lists of youthful achievements in diverse kinds of endeavor provides convincing evidence, not that the youthful musical composer has been overrated, but rather that prodigies in other lines of work have all too often been underrated or

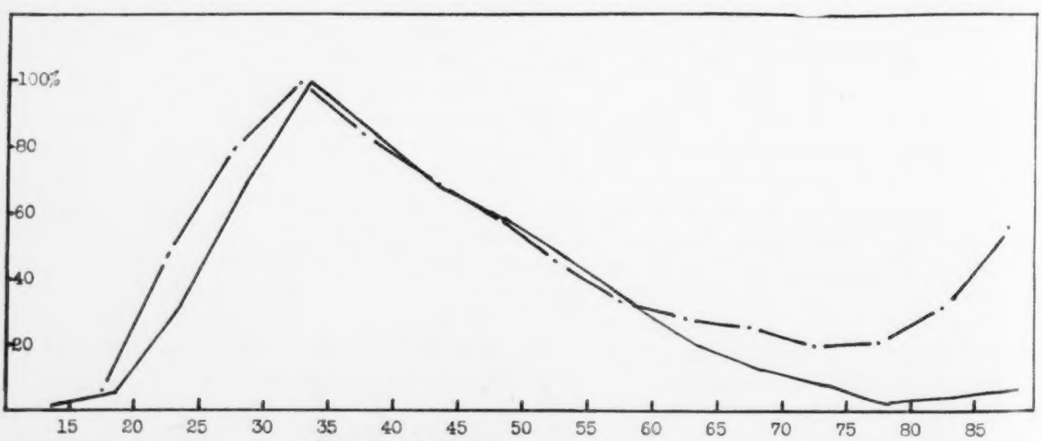

FIG. 6. AGE VERSUS OUTPUT IN SCIENCE AND LITERATURE
Solid line, SAME AS FIGURE 1. *Broken line,* 2,635 LITERARY WORKS BY ABOUT 242 DECEASED AUTHORS.

entirely ignored. In a very real sense these other prodigies have not been able to get the attention of so large an audience as have the teen-age contributors to music.

Scientific Discovery versus Literary Productivity. The rise and fall of man's best output in science, mathematics, and practical invention are shown again in Figure 6 by means of the solid line. The broken line of this figure reveals man's most creative years in 18 types of literature—2,635 literary works by approximately 242 deceased authors. The sources from which data regarding the literary selections were obtained have been published previously.[6, 7] The early ascent of the broken line of Figure 6 is probably to be accounted for in part by the fact that the literary works include numerous poems. And the late upward turn of the broken line of Figure 6 may be due in part to the fact that some of the prose selections used for constructing this curve are less select than are the scientific contributions used for drawing the solid line of Figure 6. For the scientific discoveries, the average number of contributions per individual contributor is 1.47. But for the authors the mean number of contributions per individual is approximately 2.75. The difference in the mean ages of the scientists and of the literary men at time of achievement is only 1.03 years.

Maximum Proficiency at Billiards and Golf versus Painting in Oils. The solid line of Figure 7 presents the ages at which 153 of the world's greatest artists either painted or first exhibited their one best oil painting. The method by which the 153 artists and the one best oil painting of each were identified has been described previously.[8] The broken line of Figure 7 sets forth combined data for: (1) the ages at which 42 world billiards records were broken by professional performers and (2) the ages at which 53 national professional golf championships were won either in England or in the United States. The age data for breaking world billiards records and for winning the golf championships were combined for constructing the broken line of Figure 7 both because the data for these two outstanding performances differ only slightly and also because both feats must have demanded the utmost in neuromuscular coordination. The irregular age intervals 17–21, 22–26, etc., are used in Figure 7 because, for each of the three skills pictured in this figure, maximum proficiency occurred at ages 32 to 36, inclusive.

Although the two curves of Figure 7 almost coincide from ages 19 to 39, inclusive, beyond age 39 the solid line which reveals the production of superior oil paintings sustains itself much better than does the broken line which reveals top-flight success at golf and at

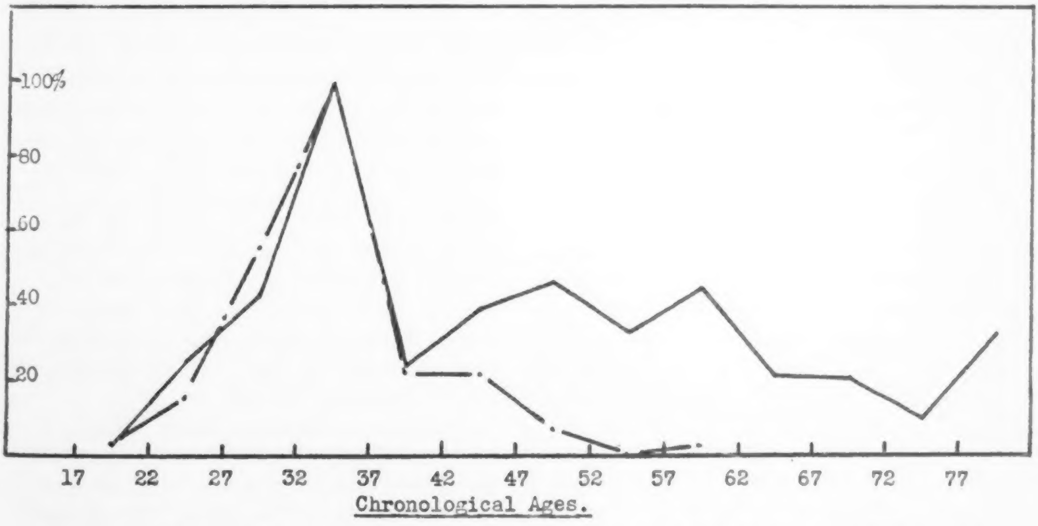

FIG. 7. AGE VERSUS PROFICIENCY IN BILLIARDS AND GOLF AND OIL-PAINTING
Solid line, 153 NOTABLE OIL PAINTINGS. *Broken line,* 93 BEST PERFORMANCES AT BILLIARDS AND GOLF.

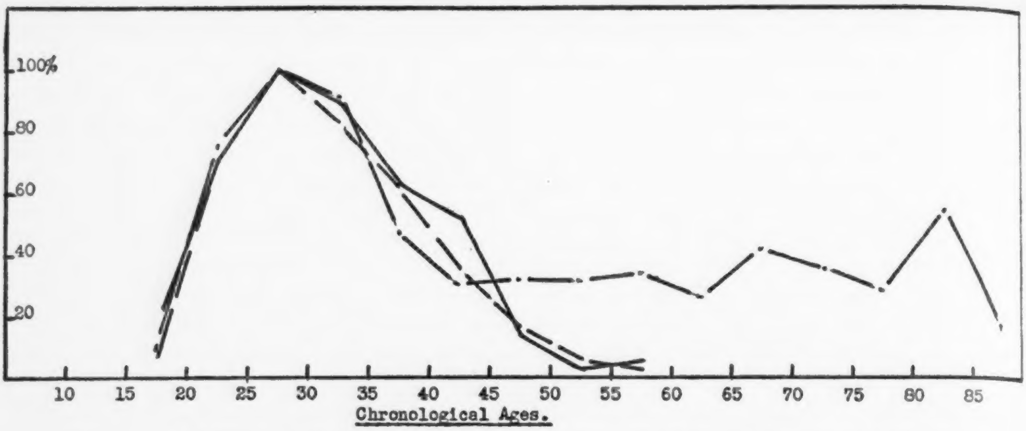

FIG. 8. AGE VERSUS MARKSMANSHIP, FECUNDITY, AND WRITING OF POETRY
Solid line, 630 RIFLE AND PISTOL CHAMPIONSHIPS. *Broken line,* AGES OF FATHERS OF 2,039,811 CHILDREN BORN IN UNITED STATES IN 1931. *Dotted line,* 797 NOTEWORTHY POEMS BY 82 WELL-KNOWN POETS.

billiards. The difference in the mean ages of the oil painters and of the athletes under consideration is 7.76 years, the means being, respectively, 41.37 and 33.61 years. If only these mean ages were known, one would hardly have suspected that the two curves of Figure 7 would so nearly coincide from ages 19 to 39. Obviously age-curves can reveal facts which bare statistical averages are unable to reveal.

The reader will perhaps find it easier to accept the early loss of maximum skill on the part of the golfers and on the part of the billiardists than to believe that a similar loss of skill overtook the oil painters during their early thirties. However, as has been explained in a previous study,[2] the accompanying age-curves should be interpreted with constant awareness of the fact that they reveal not the *rate* at which skill of the individual declines but merely those age levels at which peak performance is most often exhibited. Therefore, the long abrupt descents of the two curves of Figure 7 should be understood to mean only that ages 32 to 36, inclusive, are almost certainly the 5-year interval beyond which the typical performer has passed his zenith in the indicated fields of endeavor.

Composition of Poetry versus Biological Fecundity versus Marksmanship. The legends beneath Figure 8 supply the information needed for its interpretation. All three curves of Figure 8 have been published separately elsewhere, together with comment.[6,9] These curves are superimposed and republished here because of their marked similarity. The conventional age intervals are used in Figure 8 because the data for man's biological fecundity were grouped thus in the United States Census report. The sample of marksmen for whom data are presented by use of the solid line of Figure 8 is much larger and probably somewhat less select than are the two samples of marksmen for whom data are presented in Table 2.

Chemistry Contributions versus Professional World Championships at Billiards. In Figure 9 the solid line presents age data for 52 very superior contributions which were selected by two out of three university chemistry teachers as among the 100 greatest chemistry contributions of all time. The broken line of this figure sets forth the ages at which 136 professional world championships at billiards were either first won or retained. (The broken line of Figure 7 presented data regarding what is probably an even more difficult feat, i.e., the breaking of world records at billiards.)

For many activities usually thought of as being primarily of a "physical" nature, it is possible to find surprisingly similar age data in the realm of so-called "intellectual" achievement. For example, Figure 10 shows that for both football professionals[9] and also

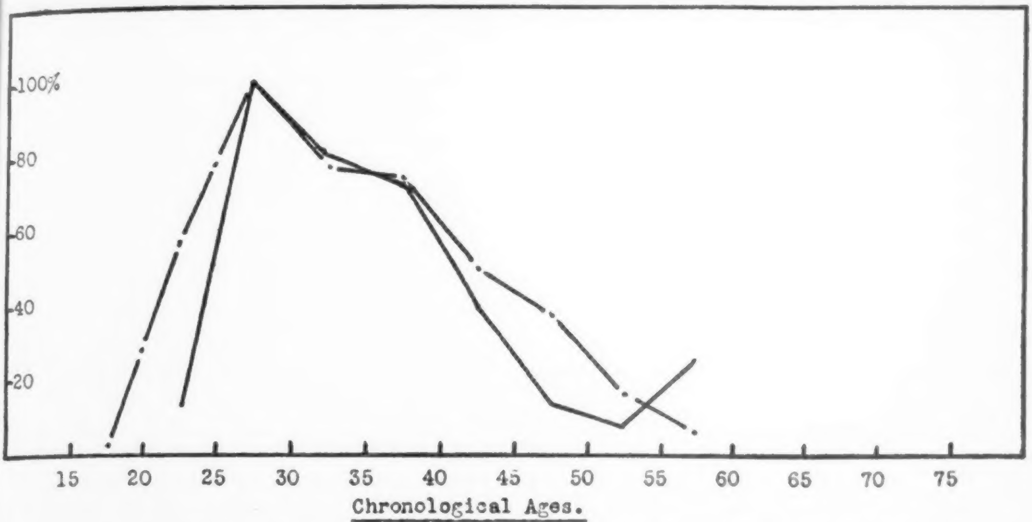

FIG. 9. AGE VERSUS OUTPUT IN CHEMISTRY AND PROFICIENCY AT BILLIARDS
Solid line, 52 GREATEST CHEMICAL CONTRIBUTIONS OF ALL TIME (SELECTED BY THREE UNIVERSITY CHEMISTRY TEACHERS). *Broken line,* 136 PROFESSIONAL WORLD CHAMPIONSHIPS AT BILLIARDS. SEE FIG. 7.

for composers of lyrics and ballads[6] the one most proficient 5-year interval is that from ages 22 to 26, inclusive. This finding for the football professionals may remind one of the preference on the part of the United States military authorities for servicemen who are less than 26 years old. One can easily believe that the ages of superior fighting ability and of superior football ability are concurrent. But why should the best lyrics and ballads be composed most frequently by youths who are the same age as football professionals?

Scientific Discovery versus Geographical Discoveries and Explorations. Are geographical discoveries and explorations "intellectual" or are they "physical" feats? Like all other human behaviors, they are at one and the same time both intellectual and physical. All thinking is regarded today as a biological phenomenon and the modern

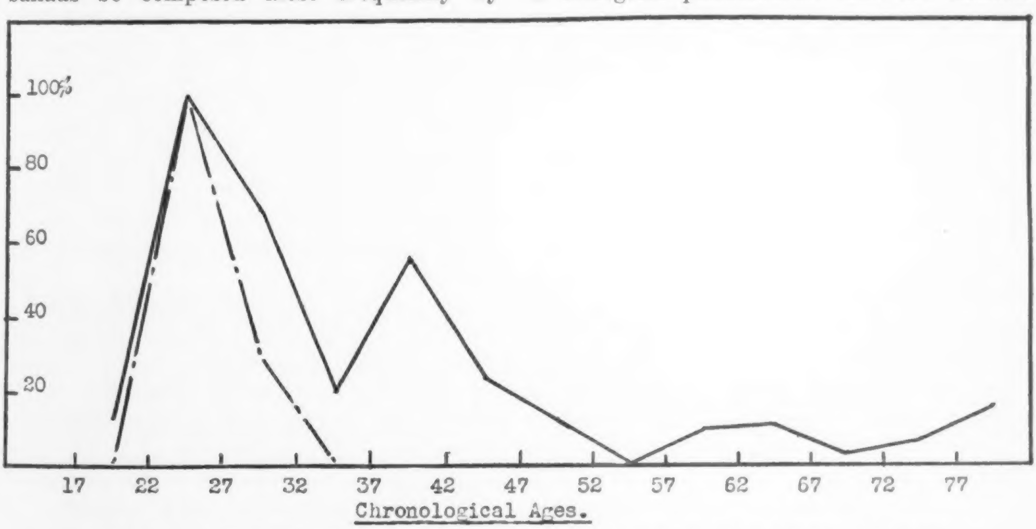

FIG. 10. AGE VERSUS FOOTBALL PROFESSIONALISM AND LYRIC-WRITING
Solid line, 148 LYRICS AND BALLADS BY 36 POETS. *Broken line,* 485 TOP PROFESSIONAL FOOTBALL PLAYERS.

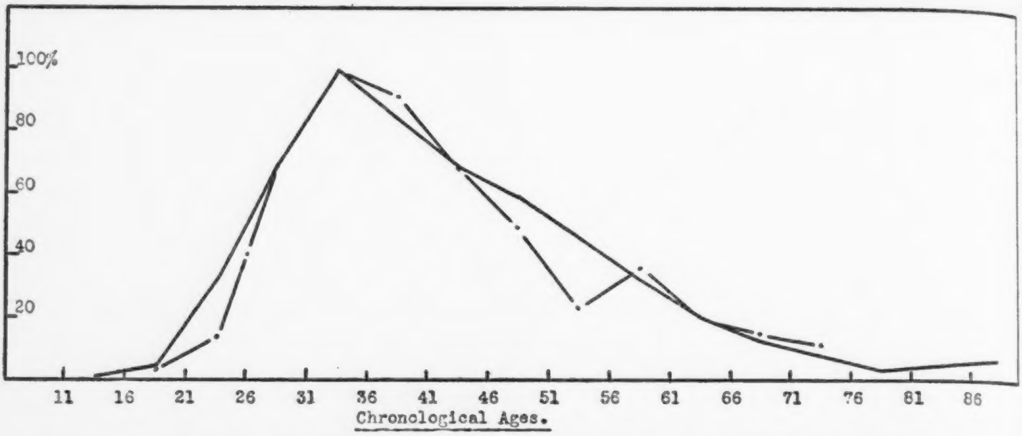

FIG. 11. AGE VERSUS OUTPUT IN SCIENCE AND GEOGRAPHICAL EXPLORATION
Solid line, SAME AS FIG. 1. *Broken line,* 202 GEOGRAPHICAL EXPLORATIONS AND DISCOVERIES (INCLUDING POLAR EXPLORATIONS) BY 152 PERSONS NOW DECEASED, AVERAGING 1.33 ACHIEVEMENTS PER INDIVIDUAL.

psychologist regards as futile the ancient attempt to distinguish between intellectual and physical performances. From this point of view the title of the present study is a bit naïve. The title was chosen because of the traditional use of the words "physical" and "intellectual."

In Figure 11 the solid line is a reproduction of Figure 1. The broken line of Figure 11 reveals the frequency with which notable geographical discoveries and explorations (including polar explorations) have been made at successive age levels.[10] Oddly enough, men seem to have explored and discovered important geographical facts with about the same frequency at different ages as they have made their other more important discoveries.

Concluding Remarks. It may require more intellectual acumen to formulate a fruitful hypothesis and to decide upon the kind of data that need to be collected, and how to assemble them, than does the actual work of collecting the factual data. In order to make proper allowance for time elapsing between the inception and completion (time lag) of a brilliant scientific study, each scientist's creative work would have had to be made a separate research problem, requiring so much time and energy that this study could hardly have been published at all. Therefore, secondary sources have been used, and time lag has been ignored except in that minority of instances in which the amount of time lag was specifically mentioned in the secondary source. When time lag was thus ascertained, fractional credit was allotted equally to those age intervals during which a given idea was being developed. However, for the reasons stated above, it seems probable that on the whole this procedure has yielded age-curves which are slightly overgenerous rather than undergenerous to the older age groups.

In this study we have purposely avoided consideration of the ages at which various types of leadership are acquired and retained. It has been shown in an earlier study that in our present-day society positions of authority, prestige, responsibility, and influence tend to be vested in (or gravitate to) middle-aged and elderly individuals.[11] The present discussion is limited, therefore, to the several types of performance cited herein. For these there is perhaps much more overlapping in the modal ages of peak performance than might have been anticipated.

For mathematicians, for inventors, and for the several other kinds of creative thinkers listed in Table 1, the median ages at time of contributing their best (or almost their best) work range roughly from 33 to 44, inclusive. But when the contributions of Table 1 are treated collectively, the one year of maximum productivity (the modal year) is age 33.

For seven kinds of choice musical selections the median ages of the composers at

time of composition or first publication range from 27 to 42, inclusive. When assembled into a single statistical distribution, however, the modal year for the composers is age 33. For the authors of eighteen types of superior literary works the median ages at time of contributing range from age 26 to age 44, inclusive, almost the same age range as that found for the composers. But when the literary contributions are combined in a single tabulation, the one year of maximum output is age 32.

The above observations possess additional interest in view of the finding that the more important championships at golf, billiards, rifle and pistol shooting, bowling, and duck-pin bowling, have also been won most frequently at ages 31 to 36, inclusive (see Figure 3). For movie actors and for the more recently born philosophers maximum success has been attained most often at age 32. For oil painters the best work has been done most frequently at *not later than* age 34.[8] Collectively, the writer's investigations to date reveal, for the following rather diverse types of performance, that peak attainment is most likely to be achieved during and early thirties:[12]

1. Golfers—professional champions, and the most recently born 50 percent of the Open Golf Champions of England and of the United States.
2. Billiardists—World Record Breakers and the most recently born 50 percent of the World Champions.
3. Pistol shooters—Individual World, National, and State Champions.
4. Rifle shooters—Individual National Champions.
5. Bowlers—National, Individual, and All-events Champions.
6. Duck-pin bowlers—National Champions.
7. Composers of seven types of choice musical selections.
8. The authors of eighteen types of select literary works.
9. Painters in oil and etchers (see Ref. 8).
10. The most recently-born 50 percent of the kinds of creative thinkers listed in Table I.
11. The most recently born 50 percent of the greatest philosophers.
12. Best money-making movie actors (see Ref. 3).
13. Geographical discoverers and explorers.

For the more intellectual performances listed above the probable error is about 7 or 8 years. For the less intellectual performances the probable error is approximately 4 or 5 years. These probable errors are approximate only; they vary somewhat with type of achievement, quality of execution, size of the sample, etc. On the whole it seems apparent that the nicest neuromuscular coordination and the best creative thinking must occur (most frequently) at very nearly the same chronological age level. This seeming agreement in such widely different fields of endeavor, as regards the age level at which peak attainment is most likely to be achieved, seems too good an agreement to be the result of mere coincidence. Could it result largely from some fundamental characteristic of the human organism—something in the nature of a fixed order of human development? It, of course, is much too early to answer such a query as this with great positiveness. However, these data seem to conceal something that needs to be explained and which, when better understood, can hardly fail to be of utmost importance to *Homo sapiens*.

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ELECTRICAL COMMUNICATION

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ELECTRICAL communication embraces a number of arts, such as telegraphy, telephony, radio broadcasting, and television, that in their early development seemed widely different but today are recognized as based on common principles of physics and electrical engineering. The separate arts differ most obviously in their terminal apparatus—a telephone transmitter for transmitting information in the form of spoken sounds does not look like a teletype sender for printed words nor like the picture-sending equipment of a "facsimile" system or of a television system. Nevertheless, all these instruments operate on common principles.

It is in the means for transmitting energy electrically between the various types of terminal apparatus that there is the greatest similarity. For example, in the long-lines plant of the Bell Telephone System a pair of conductors may at one time be carrying a telephone conversation and a little later, if the traffic requires, the same conductors may be used for the simultaneous interconnection of twelve teletype senders and printers; or they might be required to carry a program between a studio and a broadcasting transmitter, or for that matter, a picture from one newspaper to another. Much of the equipment will serve equally well for any type of electrical communication. Even when it comes to television, where the requirements are more severe because a complete picture must be transmitted every thirtieth of a second, there is still similarity of equipment and a common basis of principles. A wire or radio system, however, which can transmit a television program can be used, alternatively, for the simultaneous transmission of several hundred different telephone conversations; or, if required, it could transmit without mixing them several scores of ordinary sound programs for broadcasting stations.

In electrical communication the necessary operations have to do with either the transmission of the desired signals or the switching, routing, and control of channels over which the transmission takes place. The second group of operations is often as difficult technically and as expensive as the transmission itself. Two schoolboys with a telegraph line between their homes do not encounter this second problem of communication, but a telegraph company does. Whether its channels for communication are entirely wire or partly radio it wishes to use these facilities to their fullest, getting through as many messages per hour as possible so as to reduce the cost per message. That is one reason, for example, why machine sending from perforated tape and reception by teletype has replaced the old manual system of telegraphy; the machine can be set to run steadily at the fastest rate the apparatus and channel can take.

The problem of switching and controlling channels becomes most complex for telephone service in metropolitan areas where connections must be made between hundreds of thousands of subscribers. In a telephone central office, therefore, whether manually operated or mostly under dial control, there is always for each subscriber many times as much equipment as he has in his home.

In the electrical transmission of information the operations are basically the same whether the signals to be transmitted are according to a code of telegraphy or teletype; or according to the codes of spoken language or of music; or according to arrangements of light and shade, as in picture and facsimile transmission or in television; or according to special and arbitrary codes, such as are required in remote control by electrical mechanisms whether in industrial processes or in military operations, such as the electrical gun director of anti-aircraft batteries. Four operations are essential in every case, but two others are necessary in all except the simplest systems.

All these various operations are most easily explained by beginning with those corresponding to the ordinary transmission of speech. First there is required a power source to generate an effect that can be transmitted from the speaker to the listener; this source consists of the diaphragm and larynx of the speaker. The next requirement is a means for varying the effect so that it will convey the information it is to carry. The acoustic output of the larynx is therefore modified—*modulated* is the proper technical word. This is accomplished in the resonating chambers of the mouth which are controlled by tongue, palate, and lips. The next requirement is a medium which can transmit the modulated effect. And fourth and last, a mechanism is necessary that can detect the effect—or, in more general terms, that can *demodulate* and derive the information. The transmission is accomplished, of course, by a wave motion of air molecules, and the demodulation by the ear of the listener.

In their electrical counterparts these four basic processes are conveniently traced by considering successively an ordinary house bell-circuit, a telegraph hook-up and the simplest telephone. In the bell circuit a battery is the usual source of power; wires form the connecting medium through which can flow the electrical current; the push button is the modulating mechanism which varies the current from none to a maximum when it is pushed; and the ringer is the demodulator.

It is to be noted, that this simple circuit is limited in the information it can transmit—all it can tell a person in the house is that someone is at the door. By a simple code of long and short rings, intimates of the family can transmit somewhat more information. For more complete information a more elaborate code is required, such as those of telegraphy, but for such a dash-dot code push-button and ringer are awkward or unsatisfactory instruments; hence they are replaced by the telegraph key and the sounder which click-clacks with each down-and-up of the key.

This explanation of simple telegraphy does not follow the historical order of its development and so would seem to minimize the remarkable invention of Samuel F. B. Morse. Such, of course, is not the intent, for the only purpose here is to make clear the basic principles of all electrical communication. In the same way it is convenient to pass lightly over the wonderful invention of Alexander Graham Bell and to consider the present telephone as the next step in this exposition.

In a telephone system the key of Morse, which could vary the current only from no current to full current, is replaced by a telephone transmitter. In one form—the simplest for this exposition—the transmitter is a variable resistance, formed by loosely packed grains of carbon which respond by packing more closely or less closely as the transmitter diaphragm vibrates back and forth under the alternating pressure of the sound waves of the speech. The battery current is thereby modulated in essential conformity to the speech. The receiver, like the Morse sounder, is an electromagnet, but its armature is a thin diaphragm which can respond accurately to the variation in the current that the transmitter diaphragm causes; and so this diaphragm vibrates just as does that of the transmitter and sets the adjacent air into similar vibration, reproducing the sound.

The four essential operations of electrical communication are thus seen to be: generation of a current or other effect suitable for transmission, its modulation to put in the signal, its transmission, and its demodulation to recover, to re-create, the signal. In picture transmission, for example, the current is varied to correspond with the intensity of light reflected from (or transmitted through, when scanning films) the detail of the scene which the transmitter is observing. At the other terminal there is a light-producing mechanism which responds with light of corresponding intensity. These are also the essential elements in a television system.

The modulator and the demodulator go in pairs; corresponding to the telephone transmitter, which responds to sound, there is a receiver which reproduces sound. The former is sound-sensitive, the latter sound-active. Similarly, as noted above, in facsimile and television one element in the system is light-sensitive and the other light-

active. In a teletype system one responds to finger pressure, and the other, in effect, re-creates a finger pressure on a typewriter key.

The cause of the modulation does not have to be sound waves or light, as in the foregoing instances; it can be an electric current, as it is in the ordinary radio transmission of today. In early radio telegraph systems—which in those days were called wireless—this was not so; a current suitable for radio transmission was generated and supplied to the transmitting antenna and this current was modulated by a key in circuit with it exactly like the modulation of a battery current by a key in a wire telegraph system. Today in all radio systems for telegraphy, telephony, or television, the current for the antenna is modulated by current which comes from an ordinary wire system for telegraphy, telephony, facsimile, or television.

Radio uses in its sending antenna—and thereby establishes in a receiving antenna—a high-frequency alternating current. In the other systems so far considered in this article, the current which is modulated is a direct current like that from a battery. In the circuit connected to the battery, current flows in only one direction, determined by the way the battery terminals are connected. If a switching arrangement were introduced to flip-flop the battery connections, sending current through the circuit alternately in one direction and then in the other, the current would be called alternating. Unless the alternations took place very frequently, e.g., well above the audible limit, such an alternating current would be entirely unsatisfactory for telephony, since the slowly alternating current would dominate and mask the speech it was carrying. The current from power lines of public utility companies is alternating current. Its frequency is 60 cycles per second. That means that the current starts in one direction, rises rapidly to its maximum, decreases to nothing, reverses direction, increases to the same maximum intensity in this reversed direction and then decreases to zero current; and it goes through this whole cycle of variation 60 times a second. That cycle of variation is typical of alternating currents. Note also that "frequency" is "the number of cycles each second."

In an antenna a current of such low frequency as the usual power current would produce an entirely negligible amount of radiation. The higher the frequency, other things being equal, the more the radiation. For radio transmission currents are used which have frequencies in the hundreds of thousands; for example, WNYC in New York City, which has a frequency of 830,000 cycles per second or as more conveniently stated, 830 kilocycles, is about in the middle of the broadcasting range. Still higher frequencies are used for oceanic transmission, television, and many other purposes.

In radio transmission a current of high frequency is supplied to the transmitting antenna. *This current is modulated in accordance with a much lower frequency current upon which has been impressed by a previous modulation*—as in telegraphy and telephony—*the signal which it is desired to transmit.* Any effect produced by the current in the antenna is radiated and causes in a receiving antenna a corresponding but *much* smaller current. This is then demodulated—"detected" was the earlier word, in days when the only wireless transmission was telegraphic—and this demodulated current is equivalent except in strength to the current which originally modulated the high-frequency current. This detected current then travels over a wire circuit—short or long as circumstances dictate—to the receiving equipment, such as telephone receiver, loudspeaker, or teletype, where the final stage of demodulation is accomplished and the information it contains is made available.

This whole operation is conveniently described, in the usual technical terms, by saying that the audio-frequency current of a telephone or telegraph line is caused to modulate the radio-frequency current so as to be *carried* by radiation to the distant station. There demodulation of the antenna's radio-frequency current takes place in two steps, the first to produce a current *equivalent in significance* to the audio-frequency current, and the next to derive the significance embodied in this audio current.

The process of successive modulation or demodulation can be repeated. In so-called "carrier current" systems in the wire telephone plant of the Bell System an audio-frequency current derived from a telephone transmitter is caused to modulate a current well above the audible range; and this modulated current, in turn, is caused to modulate a still higher current. By successive operations of modulation a signal can be given a higher and higher frequency. Demodulation also can be accomplished in separate successive steps; and these steps can be chosen as desired, provided only that the total of their operations reduces the frequency of the received signal to the audio-frequency of the originating signal.

The fact that in radio transmission a signal, or a signal-bearing current, modulates a current of high frequency suitable for the desired jump through space is the explanation of the multichannel characteristic of radio. A large number of different signals—speech, music, or code—can be transmitted simultaneously over the same route, without mutual interference—provided that each signal is carried by a different frequency. In ordinary broadcasting there can be sent out a different program for every 10,000 cycles difference in the frequency of current used in an antenna. (That is true only of so-called amplitude modulation and even then depends upon the precision—and hence size and cost—of the radio receiver. In so-called frequency modulation the difference in "carrier" frequency of stations is usually 200,000, instead of 10,000, cycles per second.) To avoid interference between radio stations assigned to different frequencies there must be *stability* in the frequency of their carrier currents; this condition is accomplished usually through the use of tuning elements made of quartz. It is even more important that receiving stations shall be able to tune sharply to the desired transmission, accepting that and suppressing currents of all frequencies outside the desired frequency "band." These requirements are over and above any advantage in discrimination due to directional transmission and reception.

The ether, in other words, is a medium adapted to multichannel transmission provided that to each channel is assigned a distinctive band of frequencies and the receiving equipment is similarly discriminating. Whenever the same medium, ether, wire, atmosphere, or sea water, is to carry simultaneously and without interference more than one message there must be performed appropriate operations of *selection*, of which the tuning of home radio sets is a crude example. This is the fifth of the six operations which are basic to electrical communication.

Selecting according to frequency, years ago, made possible the simultaneous transmission over a single pair of wires of a telephone conversation and a telegraph message. A telegraph signal manually sent occupies a frequency band from about zero to a hundred or so cycles per second. A telephone conversation requires a frequency band from about 200 cycles per second up to two or three thousand. At the central long-distance office where they are received they can be separated by a "composite set," formed by inductances and capacitances, which lets through the telephone currents but diverts the telegraph currents toward their own receiving station and its sounder.

That was an early instance of multichannel operation, involving selection according to frequency. In a manner similar to that of radio transmission, using different frequencies to carry different messages, wire systems have been constructed which permit as many as 480 simultaneous but independent telephone messages.

In such wire systems—so-called carrier current systems over coaxial cable—the signal-bearing currents during transmission are highly attenuated, that is, weakened. The physical explanation is difficult and usually expressed with mathematical symbols, but the fact remains that alternating currents in traveling along wire lines, even perfectly insulated lines, suffer continuous reduction in strength, and more so in higher frequencies than in lower. In extreme cases the current may be reduced ninety percent a mile. That means a mile out it will be only one tenth its original value; and only a tenth of that, or one hundredth of its original, two miles out. Such weakening will soon make

the signal too small to affect the receiving apparatus, as well as so feeble as to be drowned out or masked by any interfering currents that may be picked up en route. Therefore, amplification along the route is necessary; this is accomplished by introducing electron tube amplifiers in proper circuit arrangements at regular intervals along the line.

This operation of amplification is the sixth of the operations required in electrical communication. These operations may now be summarized as follows: generation (of a current of appropriate frequency—remembering that the direct current of ordinary telephony is zero-frequency); modulation; transmission; selection, according to frequency; demodulation; and amplification at any stage where it is desired. In radio, amplification can be introduced only at the terminals, first to build up the signal before supplying it to the antenna, and second at the receiving station to increase the feeble effect to adequate intensity. At the latter station amplification may be introduced immediately upon reception and before any demodulation; and successively after each intermediate demodulation until the audio-frequency is supplied to the final demodulator which re-creates the signal. Along wire lines, whether carrying the audio-frequencies of ordinary telephony or the higher frequencies of carrier-current transmission, amplification can be introduced where and as required.

Electrical communication can be described in terms of signals and terminal apparatus as telegraphy, telephony, television, etc. It can also be described in terms of the medium through which transmission takes place, as through wire or by radio through the ether. The wire medium may be ordinary open wire, twisted pairs in cable sheaths, coaxial conductors where one is a cylinder surrounding the other, or so-called wave guides which, in effect, are metal pipes that enclose a portion of the ether and guide transmission. These media differ characteristically in the efficiency with which they can transmit various frequencies, but within those limits and when supplied with properly modulated current all of them can transmit signals of any of the kinds previously mentioned. Transmission also can be conveniently classified according to frequency; for example, audio, wire-carrier, and radio. The upper range of wire-carrier frequencies overlaps the range of frequencies used for ordinary broadcasting. The radio range, however, extends many times higher. The frequencies near its presently practical upper limit are also those which are suitable to wave guides.

Summarizing, it is to be noted that in electrical communication the historic divisions, like telephony or radio now overlap and are no longer sharply distinguished. In any communication system, however, will be found four, or more, of the six basic operations[1] of generation, modulation, amplification, transmission, selection and demodulation.

[1] Using the terminology of this article there arise cases where the operations of generation and modulation are performed by a single piece of equipment, as in the sound-powered telephone. In this instrument, which was the first to be invented by Bell, the sound waves vibrate a diaphragm in the field of a permanent magnet and so generate corresponding currents in a surrounding coil. In principle, the transmitter is just the ordinary receiver. Conversation is possible between two ordinary telephone receivers, speaking into one and listening to the other.

For simplicity in the preceding discussion the operations of converting energy of wave motion in air into signal current and vice versa have been called modulation and demodulation. It is usual, however, to restrict the terms modulation and demodulation to shifts in signal frequency and not to apply them where energy changes from one medium to another, as from electromagnetic to acoustic. Strictly speaking, the key, the telephone, the receiver and sounder are not modulators or demodulators. But little is lost by so calling them; and much, it is believed, is gained in simplicity of exposition.

A BIOLOGIST REFLECTS UPON OLD AGE AND DEATH*

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A year ago I passed the biblical milestone of three-score-years-and-ten. One who has done this must admit to being an "old man." Now and then, we hear the boastful claim of a man of my age that he "feels as young as he ever did." I make no such absurd claim. While keeping up, to a limited extent, my professional labors, I am conscious of both physical and mental deterioration. I shall not discuss the former. Few persons outside the medical profession are interested in senile pathology. But the mental life of an aging man, if honestly told, may present some points of interest.

The chief change which I can detect is an obvious and familiar one, the lack of driving power. It takes me longer than formerly to think a thing through, and I am less likely to be successful in the attempt. I find it increasingly difficult to concentrate upon a problem or even a simple bit of reading. Also mental fatigue ensues far sooner. That earlier enthusiasms have largely waned is, of course, part of the same psychophysical picture.

On the whole, the world appears less vividly real to me now than in earlier life. My sense-organs are nearly as keen as ever, but some sort of subtle veil seems to have interposed itself between me and the rest of things. Impressions, whether of persons or objects, are likely to require repetition if they are to register beyond the passing moment. And when repeated they often come to me as wholly new experiences. Or at least they seem so until I have had time to recollect.

The failing memory of the old is only too familiar to everyone, whether he has already experienced it or has merely witnessed it in others. Almost equally familiar is the distribution of remembered facts in time. I can, for example, recall the scientific names of some animals and plants which I learned in my teens, and which I have seldom thought of since. Nowadays, the names are far less likely to stick. In some cases, too, I remember more of the contents of a book which I read in my student days than of one which I read a year or two ago. Naturally, learning has become a much more difficult task. From time to time I am made aware that some recent experience has dropped out of my mind completely. And I reached, some years ago, that rather embarrassing stage when I halt abruptly in conversation baffled by some elusive name or word with which I may have been familiar most of my life.

I have not followed the findings of present-day psychologists regarding these phenomena—whether they are attributed primarily to a failure in the mechanism of attention, or to a deterioration in the quality of the material in which the records are registered, or to something different from either of these. There is, or course, one obvious explanation of the greater persistence of earlier memories which would seem to have some inherent probability as a partial explanation of the facts. Those were the first experiences on the ground and they pre-empted the territory to the exclusion of later arrivals. One's capacity for the storage of these records must, at best, be limited.

I can fully confirm the general belief that original ideas are chiefly the products of younger minds. I should be hard put to it, I admit, to define an "original idea," but I think that we all mean pretty much the same thing by the words. They are things

* This essay is offered in the conviction that scientists as a class are "tough minded" enough to face every aspect of reality, even some of those aspects which may be repulsive to more timid souls. I am firmly of the belief, too, that the discussion which follows relates to matters which are susceptible of scientific approach, and that it is, therefore, strictly relevant to the pages of a journal of popular science. In fairness I should state that this essay was commenced, and most of it written, as much as ten years ago. This circumstance should be borne in mind by anyone interested in evaluating the present mental status of the author! This discussion has been revised from time to time, however, and it represents my present views upon the topics dealt with.

which frequently seem to come to us from without, which "enter our heads," as we say, with or without a previous period of mental effort. Yet, curiously enough, we prize them as the most nearly our own of all our possessions. Whatever their source, they pay much less frequent visits to the senescent brain. Much that we say and write in our later years is material which we threshed out earlier in life. It may seem to be new at the time of its final emergence—possibly we may never have said it before—but the matter, in many cases, was thought out years earlier. Most of the ideas and points of view in which I take any personal pride at the present time I can trace back to the third or fourth decades of my life, or perhaps earlier.

Nevertheless, I do not think that the facts justify the youthful conception of an old man's thinking as being the mere mechanical repetition of mental processes which were started in earlier life and are continued only through force of habit. A considerable capacity remains for the rearrangement of old elements into new patterns. Even the dotard who tells the same story for the hundredth time probably makes some little variations in telling it.

On the credit side of the account there is the generally conceded advantage of the older man from the standpoint of experience. His mental machinery may lose in efficiency with the lapse of time, but it has an increasing stock of knowledge at its disposal. And this stock of experiential material keeps on growing throughout life, or at least until senile amnesia gets the upper hand. Some time one of our experimental psychologists —if one has not already done so—will plot the curves of growing experience and of declining power in the life of the average man and determine the point at which the combined values of the two variables give the highest sum. This will reveal the time at which the "ripened judgment" of later life reaches its peak, at least for that mythical being, the "average man." One would have needed entirely different curves for Justice Oliver Wendell Holmes, Doctor W. W. Keen, or James McKeen Cattell.

Old age is frequently pictured as a bleak period—the "winter of life." This, as we all know, is subject to numerous exceptions, but statistically the picture is little exaggerated. The aging person not only loses some of his chief sources of enjoyment, but in a greater or less degree he loses his capacity for enjoyment. On the other hand, his sources of suffering usually increase, while his capacity for suffering is probably little diminished. "The best is yet to be" is a beautiful expression of pietistic optimism, but it is worth noting that the author of these words was far from having reached "the last of life, for which the first was made." Another poet is perhaps more realistic when he speaks of the "lean and slippered pantaloon."

There are many, let us grant, who pass serenely through this period of life to the end, and are able to say with truth that they are happy. In general, it is likely that such persons have not suffered the worst of the "slings and arrows of outrageous fortune." However, the chief explanation is doubtless not to be sought in external circumstances. Their happy state is a state of mind, dependent upon their temperament and their philosophy of life. So far as these are matters of organic inheritance, we can do little to control them. The most sanguine eugenicist has not proposed a way of breeding for optimism. But the probability is that temperament and *Weltanschauung* are in no small degree the product of early environment. If so, the ideal education would be that which would train the individual to face life, and in the end old age and death, not only courageously but contentedly. How far we are from such a goal is evident from the fact that few persons associate the word education with guidance in these directions.

This last is the traditional sphere of religion. But religion, in the sense in which most of the world uses the word, is rapidly losing its hold upon thinking persons. Plainly, some more intelligently conceived means must be found of bringing people to "accept the universe"—to appreciate its beauty and blink its hideous cruelty. This key, when found, will consist in a drastic remodeling of our psychophysical

reaction patterns and not in the establishment of mystical relations with any outside power. "The Kingdom of God is within you!" But only the wildest enthusiasts would date our arrival at this goal within any specified number of generations. In the meantime, those who are dominated by wishful thinking, along with that vast multitude who scarcely think at all, will take comfort in the notion of a "future life." Perhaps it is best so, at least for those who are not likely to be disillusioned by the growth of their own minds.

And now for my reasons for rejecting that comforting illusion. We may grant at once that science is not in a position to "solve" this problem in the sense in which it solves problems of physics or chemistry or biology. Very probably it never will be. But I do insist that, however poorly he may be equipped for the task, the scientist is better equipped on the average than the person who lacks the scientific background. I have in mind, of course, the scientist who is also a constructive thinker, not the mere cataloguer or routine observer.

Confessedly, the grounds for one's beliefs respecting such a problem as that of human immortality are largely matters of common experience which we all share alike. The scientist's chief advantage in dealing with these matters lies not in his exclusive possession of specially relevant data but in his more nearly impersonal and objective approach to the problems involved. This is written in full realization of the dogmatic and speculative character of much recent science, and a recognition of the obsessions which beset some of its votaries. To one who is layman both in theology and in recent metaphysical physics, there would seem to be little ground for choice between such a religious doctrine as that of "transubstantiation" and such a scientific doctrine as the "principle of uncertainty." They seem equally incredible, if not indeed both fundamentally unintelligible. But few would probably doubt that by and large the scientist is far more generally guided by evidence than the theologian or religious philosopher, and far less frequently by preconceptions or emotional bias.

It is true that these assertions respecting the *relatively* favored position of science in interpreting man and the Universe are quite contrary to claims which are often made by the devotees of organized religion, claims which are too often chivalrously conceded by scientists themselves. The two fields of thought, it is contended, are quite distinct and unrelated, and the problems of each should be left to its own votaries. "Render unto Caesar," etc. Who are better fitted to pass upon the problems of religion than the "specialists" who have devoted their lives to this field of study?

Such an argument ignores, of course, the fact that the "specialist" in religion receives his fundamental data through essentially different channels from the "specialist" in science. The latter is taught, wherever possible, by observation, demonstration, and experiment. In theory at least, every conclusion reached could be checked by the student, if given adequate time and equipment. The "specialist" in religion, on the contrary, receives his fundamentals mainly on authority, and under conditions such that any really searching criticism is discouraged or forbidden. That scientific branches are also frequently taught dogmatically to the student is a lamentable fact, but it does not affect the average accuracy of my statement.

What then does science have to say regarding this fundamental tenet of almost all religious faiths—the belief in the survival of the individual human soul after death? It is true that science, as such, has no direct answer to give to this question. But it can point to facts which must be reckoned with by anyone presuming to answer them. And it must insist that the question be answered, if at all, in the light of such facts as we have, and not as the mere expression of human hopes and aspirations, or of dogmas resting on authority.

The present writer can not presume to speak for that omniscient, if nebulous, entity "Science." He leaves that to the newspaper reporters and headliners. But he can speak for one scientist of mature years and rather varied experience, who has given thought to these matters throughout most of his life. And he can add his personal conviction that the views here expressed will meet with the

assent of many, if not most, of his professional colleagues.

To my mind, any belief in the permanence or ultimate importance of the human individual is rendered untenable by considering the ephemeral nature of individuality in general, organic and inorganic alike. Our physical Universe is made up of temporary aggregations of matter and energy, ranging from atoms to spiral nebulae, from Mendelian genes to highly organized plants and animals. Drops of water, crystals, all "objects" of solid matter, waves on the ocean or in the "ether," rivers, lakes, mountains, continents, worlds and galaxies; chromosomes, nuclei, cells, leaves, bones, organs and entire organisms; social aggregations of insects and of man: all these enjoy a period of individualized existence, be it measured in fractions of a second or in billions of years. All, in time, are disintegrated into simpler constituents, and lose their identity in a common magma, out of which a new stock of individuals is continually being differentiated. Something there is, to be sure, which is permanent, quantitatively speaking at least, be this called matter or energy, electrons, protons, photons, quanta, or any other symbol for the unknown. But the integrated units which are organized out of this are in perpetual flux. In the living organism, indeed, the constituent matter itself changes continually, even during the lifetime of the individual. Such brief permanence as the latter enjoys is one of form rather than of substance, a condition which it shares with a wave, a waterfall or the flame of a candle.

In any realistic description of nature, nothing seems more fundamental than the situation here portrayed. It was recognized by some of the Greek philosophers, notably perhaps by Heraclitus and Democritus, and was picturesquely set forth by the authors of the Indian Upanishads. "As from a blazing fire sparks, being like unto fire, fly forth a thousandfold, thus are various beings brought forth from the Imperishable, my friend, and return thither also." (*Mundaka Upanishad,* translated by F. Max Müller). Intellectually considered, this seems to me to rise immeasurably higher than the crude anthropomorphism of Hebrew and Christian theology.

Why should the human individual be an exception to this seemingly universal flux? Save for the powerful emotional bias, largely a post-mortem projection of the biological instinct of self-preservation, it is hardly likely that anyone would seriously make such a suggestion. To the biologist—at least to the biologist who is self-consistent—the notion would seem to be quite untenable. What we know of man's racial history and of the psychology of his nearer animal relatives leaves no room for the supposition that the individuality of man is a thing quite unique in the world. Any "Next World," whether it be the conventional Heaven and Hell or some mysterious existence free from the limitations of time and space, must be shared with the higher animals, if not with the entire fauna and flora of our planet. Such a possibility as this last has, of course, been frequently contemplated and almost as frequently rejected. Those who have attempted any scientific argument on the subject have sometimes made reference, by way of analogy, to the existence of "critical points" in perfectly continuous series—points like the melting-point of ice or the boiling-point of water. It has been assumed that the capacity for immortality suddenly appeared in a natural way at a definite level in evolutionary history. Is it any mere chance that this level is commonly identified with the emergence of our own species, *Homo sapiens?* An intelligent ape would doubtless set it slightly earlier in evolutionary history. The intellectual snobs among us, on the other hand, would probably exclude the denizens of Main Street—anyone, in fact, with an I.Q. lower than their own.

In addition to these more general considerations, it must be insisted that biological and psychological evidence, at the present time, seems quite inconsistent with the survival of the individual mind after death. The chief of these lines of argument have been presented many times. Since, however, they are persistently overlooked by those who adopt an affirmative standpoint on the question, they may be enumerated briefly.

Individual development, as well as the evolution of animal life, point unmistakably to the dependence of mental capacity upon

the complexity of the central nervous system. The physiology and pathology of the human brain tell the same story in greater detail. Certain mental functions are known to have a definitely localized basis. Definite injuries have definite, sometimes predictable results. One's entire complex of reactions to the outer world, including some of those which we regard as fundamental to "character," are profoundly influenced by the secretions of one's endocrine glands, or even by various drugs which may be introduced into the circulation. And here once more we may allude to the dwindling mental life of senescence.

In many well-authenticated cases the original, single personality has given place to two or more personalities, differing considerably in mental and moral traits, which control the thought and actions alternately, or even to a certain extent simultaneously. In some cases, such divided personalities have been fused together again under appropriate treatment.

There are cases in which traits that are universally recognized as "moral" ones—attributes par excellence of the "soul"—may be very considerably altered as a result of medical or surgical treatment. Which shall we regard as the "real" soul of the individual, the original, "natural" one or the therapeutically improved one? And which of the stages of our life-cycle is to be immortalized—childhood, the "prime" of life, or sensecence? And if the second, as of course you would prefer, what right do you have to make such an arbitrary choice? These and a host of other questions, as unanswerable as they are unavoidable, must be faced by anyone who essays to defend the doctrine of human immortality.

There is one line of argument to which passing notice must be given. This is the evidence derived from so-called "psychic phenomena"—the revelations from the spiritualistic "mediums." That the vast majority of these depend upon fraud, credulity, and self-deception can hardly be doubted. That there is a certain residue of fact which it is impossible to explain according to any scientific principles now known I, for one, am ready to concede as probable. That any of these facts prove or even render likely the personal survival of the individuals concerned I regard as highly improbable. This for two reasons: first, the fragmentary and downright absurd nature of the "revelations," purporting to come from those who have passed into the Great Unknown; second, the existence of a much less incredible explanation, that of telepathy or clairvoyance on the part of the entranced medium. This hypothesis—however vague and unscientific it may seem at present—is supported by some further evidence, and is less glaringly in conflict with the totality of known facts.

Such a dismissal of the arguments from spiritism is doubtless somewhat dogmatic It may, of course, prove in time to be unwarranted. If so, our whole discussion of personal immortality would have to be rewritten, though this possibility seems at the moment to be extremely remote. In any case, it must be recognized that crucial evidence as between these two rival interpretations of the phenomena will be extremely difficult, if not absolutely impossible to obtain. I mean such evidence as is ordinarily demanded in scientific procedure.

There seems to be little doubt that the craving for personal survival is almost universal among civilized mankind. The fear of death is only partly a fear of the probably painful final struggle. What we dread primarily is extinction, and this is doubtless true even of vast numbers of persons who *think* that they believe in immortality. They think so only until they face death in reality—either their own death or that of some loved one. Then it is only too plain that their confidence has left them, else why their terror or their grief? One of the most curious and pathetic facts of human existence is the tenacity with which most persons cling to life, however tragic that life may have been at all times, and however painful its last stages. The patient "struggles" or "fights," we say, for life, and that, in many cases, is no exaggeration.

How shall we explain this tenacity with which we cling to an existence which may have contained a heavy preponderance of suffering? From the evolutionary standpoint, it is easy to understand our powerfully negative attitude toward death, as an

"adaptation" which we owe to the operation of natural selection. Within the limits of its applicability, such an "explanation" is doubtless altogether correct. As William James says: "An animal that should take pleasure in a feeling of suffocation would, if that pleasure were efficacious enough to make him immerse his head in water, enjoy a longevity of four or five minutes." (*Principles of Psychology*, vol. 1, p. 143).

But this instance shows in a striking way the incompleteness of the kind of explanation which natural selection is able to furnish us for our mental life. To say that in the struggle for existence all those individuals were eliminated which failed to "cling to life" with sufficient tenacity is doubtless strictly true, but to say this is hardly to render a satisfying account of the mental attitudes concerned, *from the inside.* It is probable that most persons have a more or less profound horror of extinction, and it is likely that most persons in advanced life find existence tolerable only in so far as they exclude that prospect from their thoughts. Suicide, far from being "cowardly," as is so often pretended, is for most persons an act of supreme courage. Is it not really cowardice which has prevented most lives from being ended prematurely at moments when conditions seemed intolerable?

Why should there be anything so repellent in the idea of going to sleep peacefully and failing to awake? One reason seems to be that we are unable to picture to ourselves a state of nonexistence and do not really have in mind a passage into total oblivion, but something far more positive than this. Do we not in reality picture to ourselves a bleak, lonely, shadowy sort of existence, deprived of everything that we have valued or enjoyed? As John Burroughs wrote: "We look upon death as an evil because we look upon it from the happy fields of life, and see ourselves as alive in our graves and lamenting that we are shut off from all the light and love and movement of the world. Does our prenatal state seem an evil?" (*Accepting the Universe*). And very similar words were written by Lucretius nearly two thousand years earlier:

> Therefore when you see a man bemoaning his hard case, that after death he shall either rot with his body laid in the grave or be devoured by flames or the jaws of wild beasts . . . he does not methinks really grant the conclusion which he professes to grant . . . nor does he take and force himself root and branch out of life, but all unconsciously imagines something of self to survive. . . . Hence he makes much moan that he has been born mortal, and sees not that after real death there will be no other self to remain in life and lament to self that his own self has met death. . . . (*On the Nature of Things.* Munro's translation, London, 1913, p. 113.)

When we can exorcise this devil from our minds, death and old age will have lost one of its chief terrors. Will this release ever be possible except by displacing that old illusion with some new one? To a vast number of us, the consolations of religion in this field have totally lost their effectiveness. Whatever spiritual reorganization may be in store for mankind will probably be in the direction of humanism—a stimulation of our race-consciousness and a repression of our individualistic self-seeking. We can hardly doubt that a person thoroughly imbued with this spirit would face his own annihilation with greater complacency. A belief in the continuance and progress of his race would be a potent source of consolation. It would be a matter of interest to know whether the fanatical zeal for social betterment which is said to pervade nearly all classes in present-day Russia has not affected the attitude of the individual toward death. Be this as it may, any such spiritual reorganization, for mankind at large, lies too far in the future to benefit those of us who will soon face the issue.

However absurd it may be to think of all these innumerable human personalities, past and present, as surviving as such after death, there is one sort of immortality which seems to me altogether credible. Physics and chemistry have long insisted upon the conservation both of energy and of matter. While these assertions do not mean exactly the same thing now which they did thirty years ago, there still seems to be a unanimous belief in the persistence and indestructibility of certain fundamental elements which underly physical phenomena. This has prompted many to suggest a probable "conservation of spirit;" and to those who

recognize the thoroughgoing interdependence of mind and matter, the suggestion has much in its favor. Regarding the interminable philosophical puzzle of "the relation between mind and matter" I have nothing to say. But one thing seems to me certain. The individual "mind" is no more likely to be permanent than the individual material "object." If there are unitary, indestructible mental elements, they are subject to the same vicissitudes of aggregation and dispersion as are the elements of the physical world. Indeed, the underlying elements in the two spheres may be identical.

There would seem to be little basis here for the kind of "immortality" which the human individual craves. The cosmic deck is continually being shuffled, and new hands continually dealt out. But this "deck" comprises billions of billions of cards, with possibilities of combination which could not be represented in figures, even though our figures were made to fill all the printed pages of all the books that ever existed. And supposing the same combination of mental elements did chance to be repeated, should we have the same "person?" And if so, what shall we say of the vastly greater proportion of more or less close approximations to the original pattern which would come to pass according to the principles of probability?

This question of personality is incredibly puzzling. Should we value a future life between which and our present life there was a complete gap in our memory? And would it be the same "person" who survived? If such an imagined situation seems altogether unsatisfactory to our present cravings, how much more so is the notion of a universal shuffling of the mental elements?

At the time of recording the foregoing train of thought some years ago, I was under no illusion regarding its originality. I was, however, somewhat amazed to learn a few months later how closely I had paralleled the thoughts of Lucretius, at that time quite unknown to me.

> And if time should gather up our matter after our death and put it once more into the position in which it now is, and the light of life be given to us again, this result even would concern us not at all, when the chain of our self-consciousness has once been snapped asunder. So now we give ourselves no concern about any self which we have been before, nor do we feel any distress on the score of that self. For when you look back on the whole past course of immeasurable time and think how manifold are the shapes which the motions of matter take, you may easily credit this too, that these very same seeds of which we now are formed, have often before been placed in the same order in which they now are; and yet we can not recover this in memory: a break in our existence has been interposed, and all the motions have wandered to and fro far astray from the sensations they produced. (Munro's translation, p. 112).

Another very ancient notion, and one which also seems to have much plausibility, is the idea of a cosmic mind, possessed of a perfect memory. From this the individual soul has proceeded; into it it will return. "As the flowing rivers disappear in the sea, losing their name and their form, thus a wise man, freed from name and form, goes to the divine Person, who is greater than the great." (*Mundaka Upanishad,* Max Müller's translation). The insistence of the wishful thinker that all his efforts and experiences and sufferings shall not have been in vain would realize its fulfilment in such a picture. But in that picture would *he* be there at all—except as part of a picture? By wishing hard enough, our wishful thinker might be able to answer the question in the affirmative. But I cannot.

THE SPIRIT OF TRUTH

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CONSULTING ENGINEER, NEW YORK, N. Y.

It is expedient for you that I go away: for if I go not away, the *Comforter* will not come unto you; but if I depart, I will send him unto you (John 16: 7). Howbeit when He, the *Spirit of Truth,* is come, He will guide you unto all truth: for He shall not speak of himself; but whatsoever He shall hear, that shall he speak: and He will shew you things to come (John 16: 13). And that He may abide with you forever; even the *Spirit of Truth* . . . (John 14: 16). But the Comforter, which is the *Holy Ghost,* whom the Father will send in my name, He shall teach you all things, and bring all things to your remembrance, whatsoever I have said unto you (John 14: 26).

Here we have Christ's own clear and concise definition of the Holy Ghost as the Spirit of Truth, which is also the Comforter. All three terms are used synonymously.

We have been taught to think of the Creator in terms of the Holy Trinity, God the Father, God the Son, God the Holy Ghost. Concerning God the Father and God the Son, the Church has preached and taught throughout the centuries. Its most erudite scholars and theologians have instructed our minds to conceive, each one for himself, no doubt, but nevertheless to conceive, some idea of God the Father and a much clearer idea of God the Son.

But the Church has neglected to give us any commensurate teaching regarding the Holy Ghost. Yet the fact remains that on the eve of his departure Christ instructed his disciples that in his absence he would pray the Father who would send the Holy Ghost, the Spirit of Truth, and "he shall teach you all things."

The Holy Ghost is the Spirit of Truth. Upon this Spirit of Truth must we depend according to Christ's own words for "being taught all things." How simple this instruction, how direct! Many fine Christians wish they were able to ask Christ for his answer to some questions, to solve some one of life's baffling problems. He is answering us now. He tells us to open our heart and mind to the Spirit of Truth.

The instruction is simple and direct, yes. But the solving of the answer may require much of honest thought and time and effort in many an obtuse situation. But only through exercise of the Spirit of Truth can Christ's answer to our problems be obtained.

If we are satisfied with an answer based on prejudice or bias or with an answer influenced by gain or aggrandizement then the Spirit of Truth, the Holy Ghost, dwells not in us, and the answer we accept will not be Christ's answer.

Every false philosophy is a sin against the Holy Ghost, the Spirit of Truth. The war which today curses the world with the fires of hell is chiefly the result of wrong thinking, of false gods arising from failure of peoples and governments to be guided by the Spirit of Truth.

Thought and time and effort are essential to the searching out of Truth. The scientists of this world are notable disciples of the Spirit of Truth. They enthusiastically devote their entire lives and energies to the searching out of some small bit of truth. But as long as it is a part of Truth they are indeed rewarded. For every minute finite particle of absolute truth must by definition comprise a unit in complete harmony and agreement with the infinite truth of God himself and the universe of his creation.

The element helium, so intimately known and so usefully employed in our little familiar world, is by spectrum analysis found to exist in the stars millions of light years distant from our small planet. This and numerous other similar concrete cases exhibit the awe-inspiring principle of the universality of truth.

The mechanical and electrical engineers who design a power plant, the civil engineer who designs a bridge, and the architect who designs a great building are guided by years of study and training in the knowledge and application of the fundamental natural laws involved in each special field. The efficiency and strength and utility of the accomplishment in each and every case depend upon

the designer's thorough understanding of and complete adherence to truth and to truth alone.

Why then in designing our very lives should the Spirit of Truth be less regarded, less studied, or less emphasized?

Complete love of God and love of Christ cannot exist without love of the Holy Ghost. For love without the Holy Ghost is to love only a part of God, only a part of Christ. Therefore unless the Spirit of Truth is loved and somewhat understood, the Kingdom of God on earth will be virtually impossible of achievement.

Let us illustrate. Many of our social reformers are good and sincere people. Many of them are not so good. The good ones are actuated solely by a desire to benefit humanity, their every impulse being motivated or augmented by their love of God. Each of them usually has a special theory for improving society or some section thereof. This tends to provide them with a single track mind. They are unable or unwilling to see the viewpoints of other people. Facts, statistics, history, science, even the moral principles involved bounce off their minds like water from a duck's back. Their minds are closed to any truth which might show the falsity of their pet ideas while at the same time their souls' desire for the improvement of some class of humanity is most sincere.

For example many high-minded and unselfish reformers are devoted to the cause of Labor. They go all out for Labor's program, which denies to the individual his free-borne and God-given right to sell his services to any employer willing to hire him. Organized-labor forces such a man by fear or violence to pay tribute to the Union in order to get a job. The Union commonly and notably limits the amount of work a member may perform in a day and the day's work is limited to that of the poorest worker. Regimentation replaces individualism, and the incentive for a better quality or quantity of work is frequently killed. The enthusiastic labor-reformer is prone to argue that the exactment of a fee for the right to work is no worse than some practices in which some employers have indulged. Two wrongs, however, do not make a right, and it would seem that the reformer goes to some trouble in dodging the Spirit of Truth. This is most poignantly striking since a reformer of this class would be the first to claim his loyal adherence to the principle of individual liberty and his utter abhorrence of regimentation in any form.

On the other side of the picture there is a class of people who have no real knowledge of Labor's problems, its real suffering in many situations, and its history of evolution from wide-spread injustice, much of which still remains to be corrected. Yet the same people do not hesitate to rail at Labor and its struggle for better things. This is because they have never tried to find out how the other half lives, or to determine the truth of the problem without prejudice. Here again the Spirit of Truth is the great necessity.

The deplorable condition of our home front today is attributable chiefly to false theories. Hordes of well-intentioned people are aiding in the battering down of sound principles, aiding others in high places who are using the cloak of humanity for purely selfish and political objectives. That part of God known as the Spirit of Truth is not here, and chaos threatens. The love of only a part of God by men results only in confusion and evil.

The Church itself has been a notorious sinner against the Holy Ghost, substantially retarding the progress of man toward Truth and God. The Church insisted the sun revolved about the earth and persecuted Galileo for teaching otherwise. She regarded the growth of science and general knowledge as her deadly enemies. She countenanced the burning of witches, substituting superstition for the Spirit of Truth. Right here in this enlightened country some backward religious sects still regard the conception of evolution as antagonistic to the word of God. They are afraid that Truth may be at variance with their religion. Fear of this type prevents the clear independent thinking of many good church people. They fail to comprehend Christ's own clear definition of the Holy Ghost, the Spirit of Truth whom He designated as our guide and who would teach us all things.

We have Christ's direction in his absence to depend on the Spirit of Truth for our

guidance in all things. Never let us forget these last instructions of our Lord and Master. Truth and true Christian religion cannot fail to agree, for the Spirit of Truth is Christ's own teaching. When, as may often occur, they do not appear to agree in some particular we may be certain that our conception of one or the other is at fault.

Science in its broadest definition from the Latin *scientia* means knowledge. In the more specific sense it designates formulated or systematized knowledge, as applied largely to the discovery and application of natural laws.

It is interesting to observe that since Christ designated the Spirit of Truth for our guidance, He must have considered the human race capable of discovering sufficient truth to enable it to find its way and plot its course of development.

The emphasis should be on the *spirit;* that is, the willingness and the will to truth. Only the mind open to truth can possess the spirit. It has ever been the prejudiced closed mind which has retarded the progress of the human race toward truth and light and salvation.

Politicians in extremely numerous instances are notorious sinners against the Holy Ghost. It is so easy to prey upon the ignorances and prejudices of the classes and the masses. It is so much easier for them to secure votes for themselves by this means than to teach the truth without fear or favor. Such men are ungodly. They wickedly and selfishly retard the progress of civilization and the coming of the Kingdom. It is the duty of the Church and of all Christians to unseat these false leaders of the people.

"Thou shalt love the Lord thy God with all thy *heart,* and with all thy *soul* and with all thy *mind.* This is the first and great Commandment." This suggests that one may love Christ with the heart, God with the soul, and the Spirit of Truth or the Holy Ghost with the mind; and thus may one truly love the Creator of us all, the glorious Trinity.

A man may give his heart to Christ and his soul to God. But if he opens not his mind to the Spirit of Truth then indeed he fails to love completely, and his life can neither be fully effective nor fully godly. It should be remembered that Christ himself both lived and died for the Spirit of Truth.

The very marvelous materialistic developments of our century have been due to the scientific approach to the problems in hand. All have been achieved through the open minds of scientists and engineers, the undeviating search for truth in the field of natural law and its varied applications.

When churchmen, philosophers, statesmen, reformers, and humanity in general arrive at the point in their evolutionary development where they can and will undertake the study of the problems in their special fields with that same assiduous longing for truth which marks so distinctively the scientist and the engineer; then indeed will the Holy Ghost, the Spirit of Truth, be worshipped and glorified. Then indeed with the understanding of Christ's last instructions shall we approach the Kingdom of God upon earth.

"And I will pray the Father, and He shall give you another Comforter that he may abide with you forever; even the Spirit of Truth."

SCIENCE ON THE MARCH

PHYSIOLOGICAL RESEARCH IN WARTIME CHINA*

A REPORT has recently been received giving details on the work and organization of the Tsing Hua University Physiological Laboratory. The laboratory was established in the fall of 1938 shortly after the outbreak of hostilities between China and Japan and the removal of the university from the Peiping campus to its wartime site at Kunming in southwest China. It is one of the three divisions of the Tsing Hua University Institute of Agricultural Research and is devoted to the investigation of fundamental problems in general physiology and their application to Chinese agriculture.

The laboratory had its start in a rented classroom in one of the local colleges, with a very limited amount of equipment, secured mainly from one of the drug supply houses in Hong Kong before the outbreak of the war in the Pacific. There were difficulties in obtaining a suitable site, and during these six years it has moved not less than four times. It is now located in its own buildings in the suburbs of Kunming; its previous quarters were severely bombed by the Japanese in the fall of 1940. During that bombing, a direct hit was scored on the laboratory storeroom the day after the major part of the equipment had been moved to the new suburban site.

During the six uncertain years of its existence, the Physiological Laboratory has been fortunate in being able to carry forward a comparatively uninterrupted research program except for the inconveniences caused by the almost daily bombings of the city by the Japanese in the earlier years of the Sino-Japanese war. In addition to the laboratory's permanent staff there have been no less than two score of younger, experienced research workers who have used the facilities of the laboratory for varying lengths of time. The regular seminars of the laboratory, formal and informal, have continued without interruption and have been the source of much inspiration and stimulus. An unusual esprit-de-corps has been developed, due largely to the energy and personality of the director, Dr. Pei-sung Tang.

The permanent senior staff includes: Dr. Pei-sung Tang, Dr. Hung-chang Yin, Dr. Cherng-how Lou, and Dr. Tung Shen. All these men have studied abroad and received their graduate degrees in the United States.

THE topics of research in the field of pure physiology include:

Electrophysiology. A study is being made of the electric potentials developed in plants, especially in the sensitive plant, during excitation; in addition to visual and microscopic observations, the phenomena are being studied with the use of a cathode-ray oscilloscope. Electrophoresis measurements are being made on Chinese lacquer. Electrolytic oxidation and reduction of organic substances are being studied, including the oxidation of glucose to gluconic acid and calcium gluconate, and its conversion, through reduction to sorbitol, eventually to vitamin C.

Chemical Investigations in Plant and Animal Metabolism. This work includes a detailed study of the protein metabolism of the silkworm, especially the mechanism of silk formation in the silkworm as revealed by chemical analysis and X-ray diffraction patterns. It was for this work, carried out in collaboration with the members of the Metals Research Institute of Tsing Hua University, that the members of the laboratory received the Ting Prize award of the Academia Sinica in 1942. At present there is under investigation the mechanism of fat and protein formation in the peanut; this study is in its third year. The effect of potassium chlorate on plants is also being investigated to obtain information on the mechanism involved in the use of this substance in weed control.

Plant Physiology. The physiological applications of the auxins and vernalization are being investigated. In connection with this work an invitation has been extended to Dr. Yin to visit the University of Cam-

* A résumé of activities of the Physiological Laboratory of Tsing Hua University, 1938–1944.

bridge for the coming year. At present, a detailed study is being made of the application of auxin to the rooting of the cuttings of the tung oil tree, and the use of cold temperature, auxins, and high frequency radio waves in the vernalization of wheat.

Cellular Physiology. A series of observations has been completed on the physiology of autotetraploid barley plants, which were obtained by treatment with colchicine and which have been maintained to the fifth generation. Cellular respiration studies, a field in which the laboratory has been particularly active, are being continued with *Monascus.* The problem of the relationship between oxidation and cell development is being carried forward using the eggs of the frog as experimental material.

In the applied field, efforts have been made to contribute to the more urgent problems of the war in agriculture, industry, and medicine. Work has been carried on in the following:

Nutrition. During the earlier years of the war, members of the laboratory staff served with the Medical Relief Corps of the Chinese Red Cross and conducted studies of the Chinese Army diets. The work is being continued. Members of the laboratory have also participated in the National Nutrition Conferences held in Chungking in 1941 and 1944. Laboratory studies have centered about studies on soybeans, and especially soybean protein. It is hoped to develop more extensively the use of local herbs and foods as sources of the vitamins.

Penicillium notatum. Penicillium spores have been mailed to the laboratory from investigators in the United States, and good progress has already been made in the production of penicillin. At present surgical dressings containing crude penicillin are being distributed to local hospitals in the city for clinical use. At the same time similar types of microorganisms from local sources are being studied.

Throughout the war it has been practically impossible for the laboratory to secure supplies from abroad. This has been the most serious handicap. While this difficulty has stimulated in some instances the invention of simplified techniques to replace the use of elaborate equipment, in other instances it has severely limited the scope and development of the research problems in hand.

In similar manner, soon after the establishment of the laboratory, the supply of scientific books and journals from abroad was cut off. The British Scientific Mission and the Sino-American Cultural Office have both rendered assistance in the supply of microfilm; most of the important English-language scientific journals and important books have been microfilmed. Unfortunately the use of the microfilm projectors is dependent upon an adequate electric current supply and this has not always been available.

Papers from the Physiological Laboratory have from time to time appeared in British and American journals. To meet the more urgent needs for a publication medium, however, the laboratory has itself sponsored a wartime publication called the *Biochemical Bulletin.* This is issued at present in a mimeographed edition of four or five pages monthly and serves the research fields of physiology and biochemistry in Free China.

The report of the activities of the Physiological Laboratory includes a list of sixty papers published during the last six years.—William H. Adolph, School of Nutrition, Cornell University.

THE MAIN PROBLEMS OF PHYSICS IN THE U.S.S.R.*

The main problems of physics are still those which are connected with the war. It is difficult to enumerate—and for certain reasons impossible to name—the defense jobs of the Soviet physicists. One may judge of the importance of this work by the fact that for their utilization many new organizations have been set up under the defense Comissariats. Institutes of Physics have been entirely converted to defense work. Many physicists transferred their work for the duration of the war from laboratories to plants, ships, etc. The most delicate methods of the physics of the atomic nucleus are now being used for purposes of solving concrete military and industrial problems.

* Translated and condensed by the American Russian Institute from *Izvestia*, November 25, 1944.

In addition to defense work, there are a great many scientific problems on which Soviet physicists are working. Within the next few years we intend to concentrate all our efforts on the basic problems of science brought forth by new developments, the solution of which will open up new perspectives in the study and utilization of nature.

The research work of the last decade proved the existence of two types of cosmic rays: light electrons and mesotrons two-hundred times heavier. Academicians A. I. Alikhanov and A. I. Alikhanian discovered in the composition of cosmic rays a new, third component. The study of the physical nature of these particles will comprise the most important problem of the expedition of 1945.

Long before the war, the French physicist Auger had already discovered at great heights showers of particles, covering an area of dozens of square meters. The total energy of all the particles of such a shower is so great that we do not know any one source in nature which could create it. The largest known concentration of energy is the heavy atom of uranium, where there is a concentration up to 0.3 ergs. Auger observed showers of thousands of ergs, and A. I. Alikhanov and A. I. Alikhanian, during this year's expedition, observed showers of hundreds of thousands of ergs. We are faced with a riddle, the solution of which may change our views on the structure of the universe.

Academician O. U. Schmidt brought forward a new theory of the origin of the earth and other planets through the accumulation of universal dust, which adhered to the planets while they were revolving around the sun, and through the participation of the entire solar system in the revolving of our galaxy. He has already provided a number of convincing proofs of his contentions. Their mathematical development is our next problem and Soviet scientists are going to work on it now.

Questions pertaining to the history of the earth are connected with the properties of the earth's crust, with the origin of earthquakes, with the composition of the upper strata and the finding of valuable minerals in them (especially in the Soviet Union). All means at the disposal of physics will be used for the solution of this problem: seismic waves, created by explosions; radio waves; and electric, magnetic, and thermal prospecting. The expeditions which were conducted by the Academy of Sciences in the Second Baku, in Bukhara, and especially, the expedition this year on the Apsheron Peninsula and on the Caspian Sea, assure the success of the work scheduled for next year. Next year we expect to be able to publish conclusions on the research work conducted during the past few years on the process of the movement of air-layers and their intermingling in the atmosphere; on the nature of fogs and mists.

The work connected with the complete solar eclipse of 1945 is of special importance. Many properties of the solar atmosphere, concealed from us by the bright light of the sun, can be studied only during an eclipse. Sixteen scientific institutions will participate in the study of the eclipse of 1945.

At all times, the most important problem of physicists and chemists has consisted of the study of the properties of substances, for the purpose of mastering them and developing technological materials with the necessary properties. Soviet physicists succeeded in solving a number of such problems. They are responsible for establishing the basic laws and physical theories which explain the mechanical and electrical properties of crystals and glasses, polymers (rubber, plastics), electric insulators and semiconductors.

During the past few years Soviet physicists developed new, valuable, and easily obtainable materials: frost-resisting rubber, heat-resisting "escapon" (a product of synthetic rubber) which is at the same time a wonderful insulator in radio and many other fields. Somewhat earlier Soviet physicists introduced polysterole and titanium dioxide, which later became widespread in the electrotechnical field. All of these products are being manufactured successfully by our factories and aid in solving many difficult technological problems.

The new semiconducting materials have—in the hands of Soviet physicists—increased tenfold the current in solid rectifiers of alternating current, in solid photoelements and

thermoelements. The work, which has been interrupted by the war, will be resumed next year. In addition to the solution of practical problems, our theoretical understanding of the properties of semiconductors has become richer and more profound. And this opens up new, still unused means for improving the quality of products and their properties.

The phenomenon of luminescence by way of irradiation with an electron beam, as well as by using some chemical and physiological agents, has been known for sometime. But only of late have they acquired an extensive practical significance in war work, in the technique of illumination. The fluorescent lamps, which convert the invisible ultraviolet rays into visible light, made it possible to use the light of the gas discharge instead of the heated steel wire. This makes for a great economy of electric energy and makes it possible to create light of any tint. Soviet scientists succeeded in creating conditions under which one may accumulate in phosphors large deposits of lighting energy and with a good coefficient of efficiency utilize this accumulated supply. The study of such phenomena, projected for next year, will clarify their mechanism and bring us to still more perfect kinds of phosphors.

The utilization of spectral analysis in our metal industry, in the fuel and chemical industries is being widely developed.

The most important discovery of Soviet physicists during the past few years is the superfluidity of liquid helium when it nears absolute zero. Academician P. L. Kapitsa found and proved that under such conditions the viscosity of helium, even if it exists, is billions of times lower than in all other known liquids. That is where all the amazing phenomena come from: for instance, helium in a tube at one and the same time flows in two opposite directions; sounds of two different velocities spread simultaneously, etc.

Here, near absolute zero, new quantum properties are opening up—properties which have created a revolution in physics of the twentieth century. Further research on superfluidity has great fundamental significance.

Thirty years have already gone by since the discovery of another analogous phenomenon, which is still not understood—the phenomenon of the superconductivity of certain metals near absolute zero. And here, too, Soviet physicists theoretically predicted and proved in practice that there is no intermediate state: in the transition from superconductivity to the usual properties the metal breaks up into a number of layers which alternate from one state to another. This discovery creates a new approach to the phenomenon of superconductivity.

The Hitlerite hordes inflicted much damage on Soviet science. The famous Pulkovo Observatory, which for a century had been considered "the astronomic capital of the world," has been completely destroyed. The Semeiz Observatory was destroyed and burned down, and all its instruments, books, and equipment were stolen by the Germans and carted away in 32 trucks. In the Crimea the only marine hydrophysical station in the world was destroyed; at that station "the voice of the sea"—sound waves several dozen meters long and inaudible to the human ear—were studied. This was a discovery of Academician V. V. Shuleikin. The Germans set fire to the mountain station of the Academy of Sciences at Elbrus, where for many years cosmic rays, the irradiation of the night sky, and the physiology of man at great altitudes have been studied.

All this must not only be restored, but also perfected. Next year reconstruction of the Pulkovo and Semeiz Observatories and of the marine station will begin.

Soviet physicists have set themselves large and difficult problems. We are certain of their successful solution. The enthusiasm for work which embraces our entire country has created among scientists the desire to give all of their strength and knowledge for attaining new heights in science.—Academician A. JOFFE.

BOOK REVIEWS

EXPLORING THE INFINITE

What are Cosmic Rays? Pierre Auger. 128 pp. Illus. 1945. $2.00. The University of Chicago Press.

PIERRE AUGER's book of 120 pages has the great merit of being very short and very well written, both from the standpoint of literary style, in which the French are past masters, and also from the standpoint of clarity and simplicity. His analogies and illustrations—great assets in popular exposition—are often very illuminating.

The merits of brevity and clarity necessarily carry with them the demerits of incompleteness and one-sidedness. One inevitably sees the landscape of which he is a part more clearly than he sees and correctly appraises what is going on, and what has often earlier gone on, in remoter lands outside the range of his vision. Let me illustrate this as follows:

The American student who in the late 19th Century went to Europe for his advanced training was able, merely because he was an American, to get, and actually did get in my case, for I was one of them, a more correct appraisal of the historical development of physics than did the European student, who lived close to where much of that development had taken place.

For from German textbooks and teachers I found that I had unconsciously acquired the habit of ignoring, in my thinking, French and English accomplishments, a habit quickly corrected by later study in Paris where I again made the same discovery but in the following modified form, viz., "that almost all the great advances had been of *French* origin,"—a bit of myopia afterward corrected by a few months of study in England, itself not immune from the nationalistic disease.

But we Americans, who up to say 1900 had made very few of the fundamental advances ourselves, were fairly immune from this kind of bias and were therefore in excellent position to make objective appraisals of the real relative contributions of the different European countries. We were not blinded by any nationalistic pride in our own accomplishments, having had very few to be proud of, and we knew it. It is possible that *now*, when we are increasing our own productivity at a rapid rate, we are in danger of losing our objectivity and beginning to overrate our own importance in science.

In any case, however, it will take a long time to even up with Europe the score created by the 150 years of amazing ignorance and nonrecognition on the part of European writers of the significance of the foundations of electricity laid by Benjamin Franklin, whose "single-fluid electron theory" of 1750 is now universally recognized as that to which the whole scientific world returned about 1900, in spite of a century and a half of utter neglect (due no doubt primarily to distance) of one of the world's greatest scientific contributions.

Professor Auger, however, is a European who tries to be fair to other cosmic-ray workers, and in view of the scope of his book he succeeds pretty well, though there are enough oversights to justify the advice to those who read his book to do some supplementary reading in say two or three other books on cosmic rays before they feel that they have very much of a grasp of this field.

For example, Dr. Auger's treatment of the discovery of the mesotron seems to me quite a misplacement of emphasis. For that was a discovery made wholly by two experimental physicists, Anderson and Neddermeyer, without any assistance whatever from Yukawa or from any theoretical reasoning other than that represented by the then generally recognized Bethe-Heitler theory of the origin of showers. The very scant consideration given to Anderson and Neddermeyer's work leaves the reader with a somewhat distorted historical perspective, especially in view of the extraordinary stress Dr. Auger lays on the importance of this discovery.

These two discoverers actually worked for several years with consummate patience and skill, beginning in 1934, to avoid the necessity of postulating a new particle to account for "their observed abnormal penetrating power of tracks otherwise resembling electron tracks," a penetrating power which theorists like Oppenheimer and Bethe and experimentalists like Blackett and myself

had suggested must be due to a change at high energies in the properties of the electron itself, since we were all fully aware of the fact that the ordinary properties of electrons did not permit of the observed high penetrating power.

Only when Anderson and Neddermeyer found it proved on the one hand that no such change at high energy of the electron's properties does actually take place, even when cosmic-ray electrons up to 15 billion electron-volts were under test, and on the other hand that nonshower particles (definitely not protons) of the same magnetic curvature as shower electrons had in fact such high penetrating power that they could not be electrons, did they make their announcement, published in November 1936 and more at length in early April 1937, of the discovery of the mesotron. (See *Phys. Rev.*, Vol. 53, p. 219, footnote 7, for history of this discovery.) Even today one of the world's most competent and famous theoretical physicists recently wrote me that there is as yet no good reason for supposing that this new particle, the mesotron, whose properties are all merely *experimental* findings, is to be identified with the object of Yukawa's theoretical speculations. He suggests that this last be given some other name. In any case, I cannot find that any suggestion of any sort in this field was made by Yukawa before 1935, one year after Anderson and Neddermeyer had in one of their publications commented upon the difficulty of interpreting the high penetrating power observed in some of their tracks as either electron or proton tracks.

It is true, as Dr. Auger says, that Leprince-Ringuet did a fine experimental job when (in 1941) he got a picture from which he found the mass of the mesotron to be 240 times the mass of the electron. It would not have been a misstatement if Dr. Auger had added that this checked nicely with Anderson and Neddermeyer's determination of the value of this mass made some three years earlier (in 1938) and with at least equal reliability and precision.

I shall close with the expression of the hope that there will be many readers of Dr. Auger's fine book on "What are Cosmic Rays," and that before concluding their quest for the answer they at least read the following recent articles in the *Physical Review*, not referred to by him, which some people think give the best evidence yet found for a positive answer to the query, "What are Cosmic Rays?"

Robert A. Millikan, H. Victor Neher, and William H. Pickering, A Hypothesis as to the Origin of Cosmic Rays and Its Experimental Testing in India and Elsewhere, *Phys. Rev.* 61, 397–407, 1942.

————, Further Tests of the Atom-Annihilation Hypothesis as to the Origin of the Cosmic Rays, *Phys. Rev.* 63, 234–245, 1943.

————, Further Studies on the Origin of Cosmic Rays, *Phys. Rev.* 66, 295–302, 1944.

H. V. Neher and W. H. Pickering, Results of a High Altitude Cosmic-Ray survey near the Magnetic Equator, *Phys. Rev.* 61, 407–413, 1942.

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ELECTRONICS EXPLAINED

An Introduction to Electronics. Ralph G. Hudson. 97 pp. Illus. 1945. $3.00. The Macmillan Company, New York.

THIS book is an introduction to the science of electronics for the lay reader who has only an elementary knowledge of mathematics and physics. The preface contains a brief explanation of the notation used for expressing very large and very small numbers in powers of ten. Aside from this, no knowledge of mathematics is needed.

The first chapter of the book presents a review of modern theories of the constitution of matter. The Bohr model of the atom is discussed in some detail, with a brief consideration of the newer particles such as positrons, mesotrons and neutrinos. The principle of operation of a cyclotron is explained. The second chapter covers the flow of electricity in gases, liquids, solids and in a vacuum.

Succeeding chapters in the book deal with the essential aspects of radio communication, the reproduction of motion pictures, facsimile, sound and television, and the production of light and radiation. A chapter on industrial types of electronic power devices is included. The final chapter indicates the wide variety of possible applications of electronics. Descriptions are given of the operation of an electron microscope, the radiosonde, the radio compass, and diathermy equipment. A list of conversion factors for changing various quantities from one system of units to another is in an appendix.

The book is adequately illustrated and contains a large number of excellent photographs. It will be of considerable interest to readers who desire to obtain an acquaintance with the working principles of modern electronic devices.

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CALL OF THE WILD

South America Called Them. Victor Wolfgang von Hagen. 311 pp. Illus. 1945. $3.75. Alfred A. Knopf, New York.

THE "them" in the title of Mr. von Hagen's book refers to four European naturalists who made explorations in South America between 1735 and 1866. They are, chronologically: Charles-Marie de La Condamine (1701–1774), Frenchman who led the illustrious Académie des Sciences Expedition to the Equator; Alexander von Humboldt (1769–1859), German baron who explored in Ecuador, Colombia, Peru, and the Upper Amazon; Charles Robert Darwin (1809–1882), Englishman who traveled on H. M. S. *Beagle* to Patagonia, Tierra del Fuego, Chile, Peru, and the Galápagos Islands and gathered enough material and ideas to revolutionize the science of zoology; and Robert Spruce (1817–1893), Yorkshireman who traveled in an open canoe over 18,000 miles through the waterways of the Amazon Valley and the Rio Negro, botanizing, filling European herbaria with the results of his prodigious plant-collecting, taking out cinchona plants for India, etc., etc., until he became one of the greatest botanical explorers in history.

It is useful to have the achievements of these titans of science recounted, and Mr. von Hagen, summoning his not inconsiderable abilities as a writer, has done a commendable job of it. He has focused our attention again on South America and on the events of the times that led to the early South American exploration. He does not include exhaustive biographies of these explorer-naturalists but describes in some detail their travels, vicissitudes, failures, and successes and stresses the importance of their discoveries in the total South American scientific picture; they are shown to be the main links in the chain of South American scientific history. Naturally, the story is not devoid of the spirit of adventure and romance, which the passing years sometimes manage to extract from even the most prosaic happenings. Furthermore, Mr. von Hagen writes with an enthusiasm for his subject that makes his book lively and readable.

As to sources, the author has drawn heavily upon the work of others for atmosphere as well as for facts, but it could hardly be otherwise in a book of this kind, which is historical and informative in its approach. Even so, the author has himself traveled in many of the South American countries he writes about and has studied firsthand their biology, ethnology, and geography. His personal experience is thus added to the documentary record to make a well-balanced and authoritative account. Primary sources, as would be expected, are the writings of the naturalists themselves—the journals of La Condamine; the voluminous letters, personal narratives, and voyages of Humboldt; Darwin's *Voyage of the Beagle;* and Spruce's journal and *Notes of a Botanist.* These have been supplemented, especially to fill in the background of the times, by many other works, including pertinent accounts of such modern writers as Stefan Zweig, Paul Russell Cutright, Robert Cushman Murphy, Geoffrey West, and S. E. Morison. All these are freely acknowledged.

The book bears this epigraph from Seneca: "Much remains to be done, much still will remain . . . nor shall any man born after the revolution of a thousand ages be denied the opportunity to contribute something. . . ." This is a truth that has animated scientists of all ages, but it seemed especially true of South America (and indeed of North America too) during the period when La Condamine, Humboldt, Darwin, and Spruce lived and worked. They opened new frontiers of scientific discovery on a virgin continent where much *still* remains to be done. Their story is fascinating and important and timely.

South America Called Them is well illustrated with halftone plates and maps and contains a perhaps adequate but none too thorough or accurate index. It is tastefully bound in blue cloth, over which is wrapped a singularly ugly green jacket. The format,

printing, and paper are above the average for these times, when, paradoxically, there seems to be too little paper for good and worthy books but plenty for colored "comic" books and other forms of unadulterated tripe.

PAUL H. OEHSER

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MEDICAL POETRY

Poet Physicians. Mary Lou McDonough. 210 pp. 1945. $5.00. Charles C. Thomas, Springfield, Illinois.

THE attempt to select the best poetry on medical subjects by medical men of all time and from many lands is a considerable undertaking. Mrs. Mary Lou McDonough, the compiler of the present collection, is an artist in her own right. She is the wife of Captain Stephen McDonough of the Surgeon General's Office in the War Department. In her search for poetry she has had access to the finest libraries in this country, both public and private. The result is embedded in a very attractive little volume of 210 pages, very carefully designed and beautifully printed on excellent paper.

Good poetry is very rare in any field of thought and judging by this collection, made on the basis of quality, it is most unusual in the field of medicine. None of the poetry reprinted here descends to the trivial commonly seen in doctors' verse as it appears in medical journals, but on the other hand surprisingly little of it is of high quality. The best selections frequently have little to do with the practice of medicine. It is probable that poet physicians have reserved their best efforts for nonmedical verse. It is difficult to see a reason for this unless poetry is for the doctor an escape from stark reality. A famous Chicago physician told me that his day was so filled with tragedy that he could not enjoy operas filled with artificially concocted misery.

Why do physicians in writing pay so much attention to the morgue, dissecting room cadavers, death, and pestilence? The body is full of adaptive devices and regenerative forces that should be the subject of joyful verse. There is no lack of material for lines of beauty, rhythm, and suggestions of significance. For many years I have seen and deplored the change that comes over medical students as they mature from idealistic, widely interested, and spontaneous youngsters into efficient, narrowed, realistic (?) practitioners. Listen to successful physicians and surgeons at the lecture desk or in society meetings. Few have enriched their vocabularies, except for technical terms, since they left college. Imagination in a crowded medical life often shrivels to small dimensions.

The book has other merits than the 186 poems which it contains. Each of the 108 authors is introduced by an attractively arranged biographical sketch. These and the poems are chronologically arranged. A final index section contains the names, birthplaces, birth and death dates when known, of 401 medical poets. Dr. Merrill Moore of Boston, who contributes five verses to this volume, is said to have written more than 50,000 sonnets. He adds a short afterthought, or memorandum, on medical poets in which he commends Mrs. McDonough for her careful gleaning of "medical poetry," most of which is junk. The poems selected are varied in theme. Few have humor. China and Japan are represented by one each in translation. South and Central America contribute few. The older literature reaches a little into Italy, France, and Germany but most of it is English and most of the recent work is American.

This book is a large and worthy effort. The verse is interesting and is not easily accessible in other books or periodicals. Its publication may unearth some hidden gems from forgotten journals. It may also prod some who have the talent and experience until they contribute to a fine art.

JOHN G. SINCLAIR

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REORIENTING THE LIBERAL ARTS

Education for Responsible Living. Wallace B. Donham. 309 pp. 1944. $3.00. The Harvard University Press, Cambridge, Massachusetts.

THE author of this book has an unusual background of experience in American business education. The Graduate School of Business Administration, with which he has been so potently related, has demonstrated that young men can be educated for greater efficiency and higher standards in business.

Since an acceptable college course is prerequisite to entrance in the Harvard Graduate School, and since young men have come to it from many colleges, it follows that there has been opportunity for conclusions regarding the general foundational education of the students. It is an old assertion, however, that preceding education is faulty when considered in terms of that which is to follow. Graduate and professional schools censure the colleges. Colleges complain about the high schools. Secondary schools talk about poor work of the elementary schools. The homes from which young children enter schools too often have abdicated many or most of their nonbiological relations with their children. And, when graduates of professional schools are employed in the affairs of life, they and the public find that there is always more to be learned and more adjustments to be made. It must always be so. Of course, the preceding schools should do better. They are constantly endeavoring to do so. Specific factual criticism is helpful. But each succeeding school must build on what it gets unless the foundations are too crumbly to serve even when considerable patching is done. The author is sometimes on one, and sometimes on another side of such questions, for in his closing chapter he says, "Of course, all educational ideals are unattainable, and by this test all education fails." By such statements from the author, the reviewer understands that the many stinging, severe, and well-founded criticisms of general education might properly have closed with assurances that much real progress has been made, but that this progress is decidedly inadequate when judged by our constantly improving ideals of what might and should be accomplished.

The discussions dealing with needful attitudes of mind and action are particularly cogent. These recur all through the book almost as an unstated fundamental theme. This fact is important since it indicates a conviction that whatever one's education or training, the most significant feature relates to any dependable attitudes which are guides in thinking and acting. In discussing engineering training and liberal education, it is claimed that a person with disciplined scientific training is likely to have a "narrowness of his point of view." It is also claimed that a person with such training "is disturbed by the confusion of facts as they occur in other aspects of life," and further that such a person sometimes resents the necessity of making conclusions in situations in which facts are unknown and possibly "unknowable." We need to recognize that certainty is relative. In the mathematical and physical sciences it is usually possible to acquire a high percentage of the facts needed for conclusions. In biological sciences, we are sometimes fortunate if we acquire half the needed facts, and in the social sciences, so-called, the variables and unknowns are such that conclusions are sometimes merely guesses regarding probabilities. The author urges that scientific training needs the broadening of liberal arts, partly to emphasize the necessity of judgments in areas in which factual foundations are scant or absent. "Every advance made by science brings a greater need for men capable of keen incisive action with reference to successive novel situations. Every such advance of science presents a more important need, a more obvious opportunity for liberal-arts colleges. . . . It is too bad that, instead of thoughtful analysis leading to affirmative demonstration of useful values, the liberal-arts colleges have so generally taken the easy attitude of disclaiming any intent or desire to be useful—truly a pathetic defeatist attitude for the custodians of the highest values and those most critically needed in the whole range of education and civilization."

The development of the sciences and consequent impact upon religion, behavior, and philosophy has removed at least part of former controls of human character. Some individuals have been "cut adrift" by removal of fear of Hell. And some base their hope of Heaven solely upon integrity of character and conformity to proved principles now observable in practical human life, and let it go at that. The tremendous gains in validity of scientific thinking have not become possessions of some people, though they may have lost the earlier anchorages to human character. Since "We have lost a sense of direction in the midst of overwhelming change," it is stated that in individual guidance and philosophy "many serious ob-

servers think we are drifting toward totalitarianism.'' This would seem to mean that some persons are afraid of individual responsibility and tend toward accepting orders from a superior who will accept full responsibility. In association with this tendency, possibly a part of the cause of it, is the decline in the extent to which family life and coherence are determining factors in human conduct.

The closing chapter (XXI) on ''Is General Education Possible,'' should be ''must'' reading for all college authorities and teachers. Undergraduate teaching is one job. Graduate teaching and specialized subject research is a decidedly different job. Eminent lecturers reciting to their undergraduate students are accomplishing little toward education. Back and forth thought analysis and conclusions based upon specific situations and problems (the case system) will require superior teacher guidance that differs distinctly from capacity and eminence in subject research. Such college teaching must become a worthy and fully recognized career, second to no other, in order that liberal college education may become a reality.

OTIS W. CALDWELL
OFFICE OF THE GENERAL SECRETARY
A. A. A. S.

FEMININE PSYCHOLOGY

The Psychology of Women. Vol. II: Motherhood. Helene Deutsch, M.D. 498 pp. 1945. $5.00. Grune and Stratton, New York.

THE first volume of this work was reviewed in an earlier issue of this journal. The present volume is devoted to women in the relation of motherhood. It is in many a ways a unique work. The contribution, indeed, which Dr. Deutsch makes in this volume towards the better understanding of feminine psychology in our society is, I believe, destined to assume classical rank. Writing out of a background of extended clinical psychoanalytic experience with women of all types both in Europe and in the United States Dr. Deutsch provides the reader with numerous basic case histories drawn from this experience and which, in this volume, are very lucidly examined and illuminatingly discussed. There is a tremendous amount of wisdom in this volume, and very deep and novel insights. All students of human nature will gain much from its reading.

In this volume, as in the first, Dr. Deutsch is concerned with the analysis and delineation of the mental life of the normal woman in our society. The pathologic aspects of woman's mental life will be dealt with in a future volume, and in still another volume the author promises to consider the cultural and social factors which influence the shaping of the feminine psyche. We look forward to these additional volumes with the greatest interest and trust that we shall not have to wait long for their appearance. The present volume cannot be too highly recommended to all students of human nature. If the succeeding volumes maintain the quality of this second volume the success of what will, indeed, be a great work is assured.

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HAHNEMANN MEDICAL COLLEGE
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BOOK REVIEWER

(*r.i.p.*)

Beneath this mossy rock in supine rest
Lies one who read the bad, the good, the best
But died, alas, from simple lack of sleep;
For through the night instead of counting sheep,
He, wretched soul, distraught as well as drowsy,
Was hunting ant- and synonyms for ''lousy.''

—PAUL H. OEHSER

COMMENTS AND CRITICISMS

Some Insect Infants

Our bugs, the author tells us, as we ramble thru his lines,
Amount, no less, excluding fleas, to fifty thousand kinds!
Then on their worms he dwells at length, with fiendish glee and skill,
And by this time my lips are pale and I am feeling ill;
But when I learn of the worm's demise, brother, I'm sicker still!
Altho I'm loath—and with regret, put Science on the pan,
When I reflect on the worms I've et, says I—"that nasty man!"

—H. E. Woodcock.

Our Dear Watson

Let me compliment you on a recent article, that by Hedgpeth on Sherlock Holmes' Medusa. I think that your allowing him to have notes and references at the rear is a splendid thing. It makes the "Monthly" a "Scientific Monthly." I found his paper very interesting. I have always hoped that somebody would take Mr. Sherlock up on the question, and our author certainly did a good job.—E. W. Gudger.

Electronics

In the June (1945) Scientific Monthly, p. 459, will be found an excellent and instructive article on the above topic by John Mills. Since I have for the past few years been making a special study of the electrostatic and the electromagnetic fields of the electron, I was greatly interested in this paper on electronics. In general, the descriptive analyses by Mr. Mills of the various phenomena to which electrons lend themselves were entirely correct; there were, however, a few descriptions in the details of which one might wish for more scientifically expressed terminology. For instance at the close of his second paragraph will be found the sentence: "They [the electrons] can also be freed by the impacts of other electrons and from metal bodies by the application of heat." There is no question that electrons are freed from metals by the application of heat, but I would seriously question the freeing of electrons by the impact of other electrons. I recognize that this is and has been a frequent mode of stating a method of freeing electrons, but if we carefully analyze the mode of collision of electrons with matter (molecules, or nuclei of atoms), as in the case of cathode rays making collision with the material of the anticathode, X-rays and not photoelectrons are the product of the expenditure of the energy of the cathode ray electron. The cathode ray electron after collision and the generation of an X-ray quantum returns as a slow moving electron and is immediately drawn to the anode.

Again, the author remarks, p. 460, "Their production of light is essentially the same as in the lightning flash. When, during the discharge, the electron meets a positively charged ion, the two oppositely charged particles may combine to form a normal atom." It seems to the writer that a high-speed electron would not normally combine with a positive ion; only when it has lost most of its energy will it do so. This is quite clearly shown in C. T. R. Wilson's chamber. A further statement is made by Mr. Mills: "Then the energy of their collision is radiated as a speck of light—as a 'photon'." To me this is a new concept of the generation of a photon. However, it appears to closely approach my view that light quanta, just as X-rays, are generated by the collision of high-speed electrons with matter, and that the energy of high-speed electrons is, in general, spent in generating radiation quanta (just as was the case with the generation of radiant heat when Planck discovered the quantum theory) rather than knocking out electrons from atoms. The question, therefore, arises: "How are electrons freed and ions formed?" This the writer can fully and scientifically explain, the explanations, however, are technical and possibly The Scientific Monthly would not publish a technical article.

My object in sending this communication is not to criticize the author of the paper on "Electronics." I consider the article well written and highly instructive. My only object was to call attention to some present ideologies in the present mode of writing about electrons, especially in reference to radiation.—Samuel R. Cook.

Soporific

In your March number the article, "The Transplantation of Democracy," by A. G. Keller consumes twelve pages in this era of paper shortage.

I read the article carefully and could not understand the beginning; it moves on, a veritable diarrhea of words and constipation of ideas, and I find no conclusion was reached; "and Lo, the phantom Caravan moves on to the Nothing it set out from."

Formerly I always kept copies of The Scientific Monthly and often reread many of the articles. The Journal has deteriorated so much recently that I look through it rather rapidly and throw it aside.

I think of the old quotation "Now, blessings be on the head of Cadmus, the Phoenicians, or whoever it was that first invented books." Now I thank heaven for a capacious waste basket.—H. W. Soper, M.D.

THE BROWNSTONE TOWER

"When shall I receive my reprints?" No question is put to us more frequently than this and none is more difficult for us to answer satisfactorily. We should be happy if we could state here that reprints are mailed within a week after publication of an issue. However, under the exigencies of wartime the date of mailing has become variable and unpredictable. So far, authors have not had to wait more than two months for reprints; perhaps they are fortunate to be able to get them at all.

Some contributors may not know that the editorial office has nothing to do with reprints except to forward orders for them to the printer. Although we have no objections to serving as intermediaries in subsequent inquiries, we should point out that the author who orders reprints is doing business with the printer and can best expedite that business by corresponding directly with our printing company (for address see masthead or blue slip).

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Ordinarily, reprints will be made on the same kind of paper as that on which the article appeared in the SM. Occasionally, however, an author has requested that his picture and biographical sketch from "Meet the Authors" be added to a blank page of his reprints. In that case coated paper might be used for reprints even though the article was published on rough paper. The printer should be consulted about the cost of this or other special services.

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